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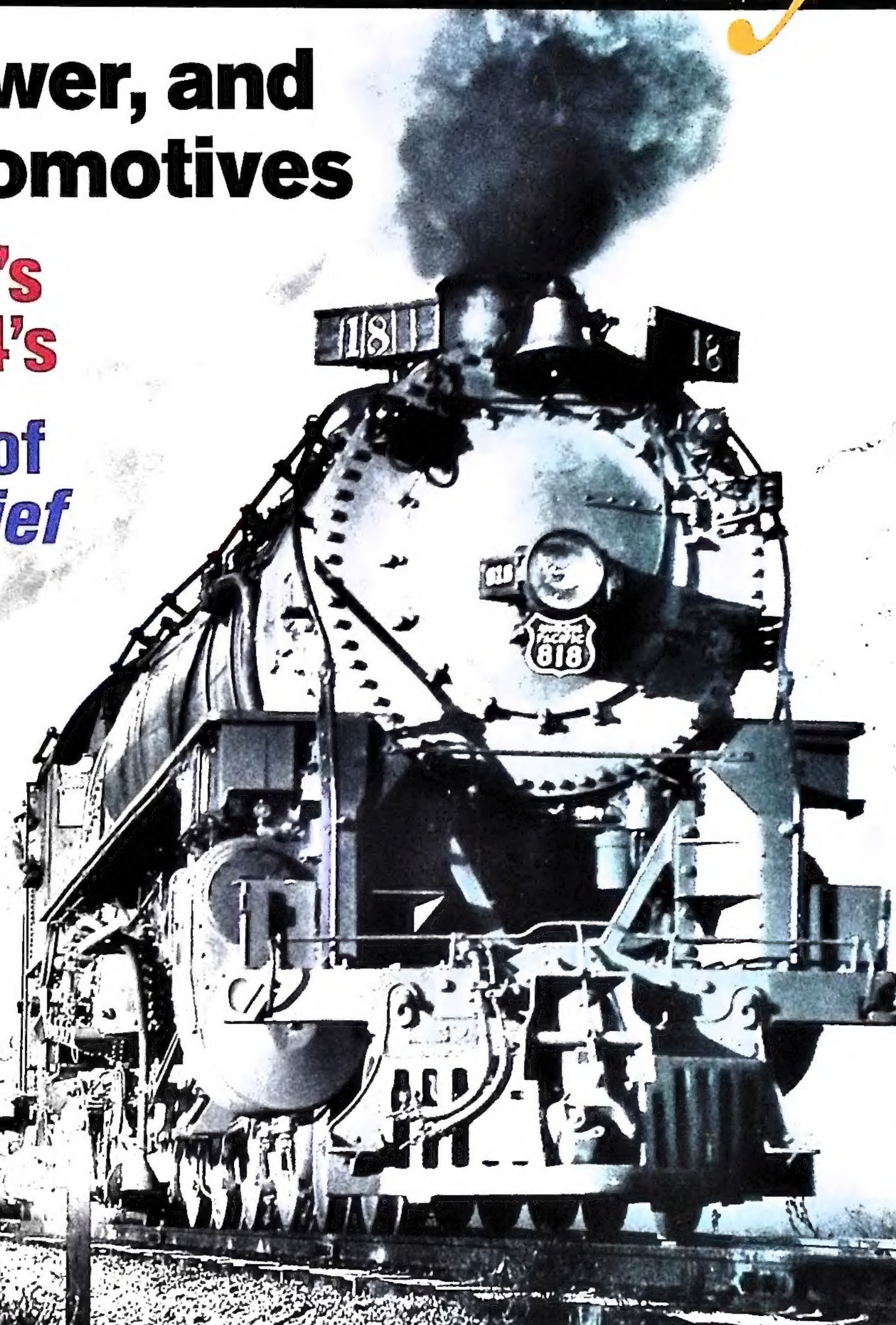

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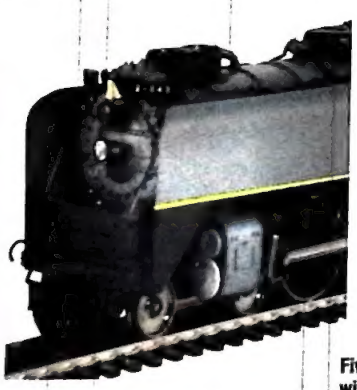
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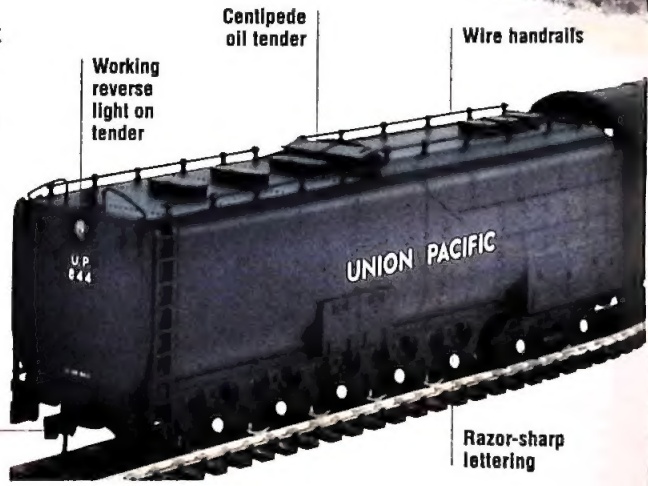

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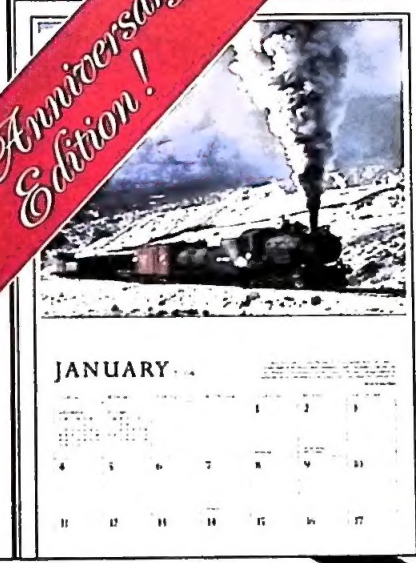

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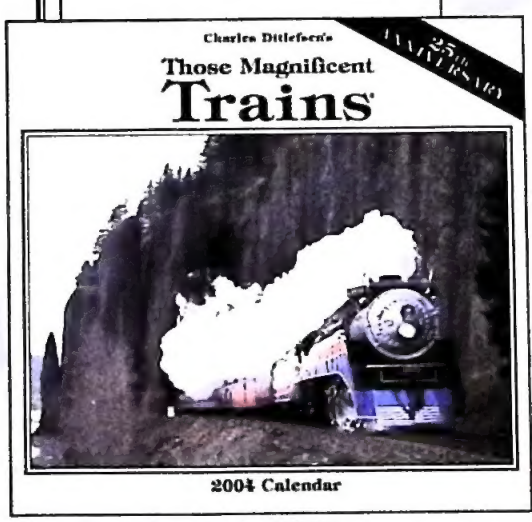

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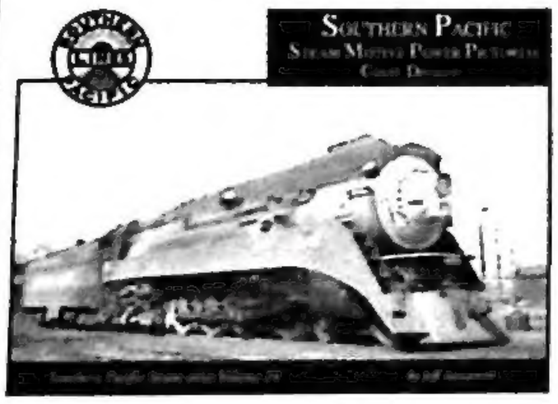

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STEAM Glory

ClassicTrains

Speed, Power, and Great Locomotives

CLASSIC TRAINS SPECIAL EDITION NO. 2 • 2004

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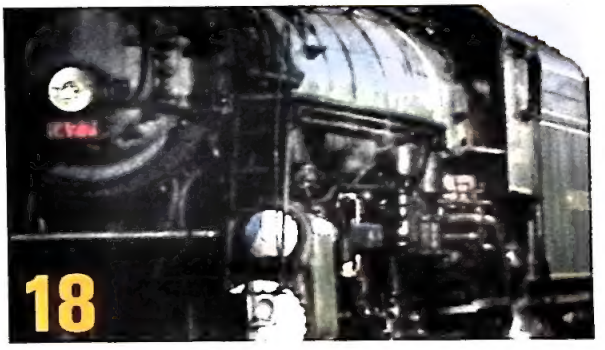

On the cover: Less than a year old, Union Pacific 4-8-4 No. 818 rushes toward Omaha, Nebr., with train 18, the *Portland Rose*, east of Huntington, Ore., on January 1, 1938. *Richard H. Kindig photo*

Steam's lasting legacy: No news from the patent office

WELCOME TO STEAM GLORY, the second annual special edition of CLASSIC TRAINS magazine. The world of steam locomotives is vast, spanning 125 years of history and encompassing everything from backwoods teakettles to sleek mainline racers—far too broad, that is, for any single publication. For STEAM GLORY, we narrowed the focus to the magnificent final decades of steam, when the great locomotives were at their fastest, most powerful best.

In this issue, you'll find profiles of three famous families of steam: Union Pacific's versatile 4-8-4's [page 8], Canadian Pacific's semi-streamlined passenger beauties [36], and Norfolk & Western's phenomenally powerful 2-8-8-2 Mallets [78]. Another article looks at fast-freight articulateds, the swift giants that became symbols of the high tide of steam development [20]. And there's a glimpse of the "extreme machines" that sought to push steam technology to even greater heights [104].

Moving beyond the locomotives themselves, we have studies of the Nickel Plate Road's modern steam servicing facilities [68]; Chesapeake & Ohio's *Badger* and *Spartan*, the last steam-powered Great Lakes carferries [90]; and a fireman's view of a 1943 trip on Santa Fe's *Chief* [46].

The "Going Out in Glory" series [pages 18, 32, 64, and 100] recalls some of the bittersweet times when, on the eve of the diesel's total victory, steam could still relive its heyday of speed, power, and dignity.

Perhaps the most eloquent of all admirers of steam was longtime TRAINS magazine Editor David P. Morgan. Referring to the steam locomotive in the April 1954 issue, he wrote, ". . . if anyone has bolted together a mechanism with just 50 percent its solid spiritual satisfaction, he hasn't filed for a patent yet." As far as we're concerned, no such patent has been filed in the 50 years since, either.

Robert S. McGonigal

W. A. AKIN JR.

For engineer or bystander, steam satisfied the spirit like nothing else.

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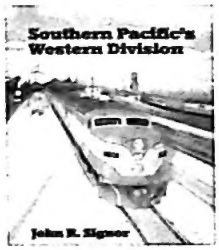
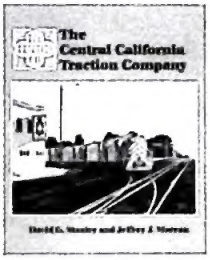


Southern Pacific's Western Division, John R. Signor

The Western Division of the SP, from Sacramento to Oakland and San Jose, and with lines to Fresno, the Napa Valley, and Altamont Pass, was a crucible of California operations. Headquartered at the famous Oakland Pier (or Mole) and handling hundreds of passenger and freight trains daily, along with ferryboats to San Francisco, in its heyday this division was in many way the vortex of SP in the West.

Hard covers, 416 pages, 8½" x 11"; 711 photographs (84 color), 23 maps, bibliography, index Price: $70



Central California Traction, David G. Stanley and Jeffrey J. Moreau

Begun in 1902, this line became the joint property of Western Pacific, Southern Pacific and Santa Fe in 1928. Electric operations ceased in 1946, but CCT forged forward with diesel power under the same ownership, with which it continues today. The road was and is known as "California's Last Interurban."

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Tank Cars, American Car & Foundry, 1865–1955, Edward S. Kaminksi

Tank cars are interesting cars, and this book shows their diversity in design, construction, and lettering schemes from 1865 to 1955. Both photos and drawings show tank cars of the world's largest builder of them, American Car & Foundry.

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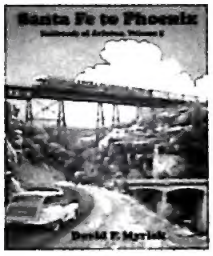

Santa Fe to Phoenix, Vol. 5 of *Railroads of Arizona,* David P. Myrick

This latest volume in Myrick's acclaimed series on Arizona railroads covers central and western roads, most notably the Santa Fe line through Prescott to Phoenix. As always in a Myrick book, the importance is clearly shown of these roads in the development of Arizona and the West.

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Pacific Fruit Express, Anthony W. Thompson, Robert J. Church and Bruce H. Jones

Pacific Fruit Express was the world's largest owner and operator of refrigerator cars. From 1906 onward, this jointly owned UP–SP operation was a leader in design, construction and operation of refrigerator cars. This new and expanded version of the 1992 edition has 32 additional pages, 46 additional color photos, new statistical information, and a number of minor corrections from the acclaimed first edition.

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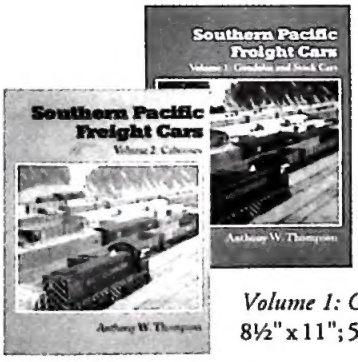

Southern Pacific Freight Cars: Volumes 1 and 2, Anthony W. Thompson

This series on SP freight cars begins with gondolas and stock cars, approximately for 1900–1960. The second volume covers cabooses, 1871–1980. The series emphasizes extensive rosters, photos and drawings of the major car classes, along with material such as construction and publicity photos, lettering drawings, photos of cars in service, and survival tables.

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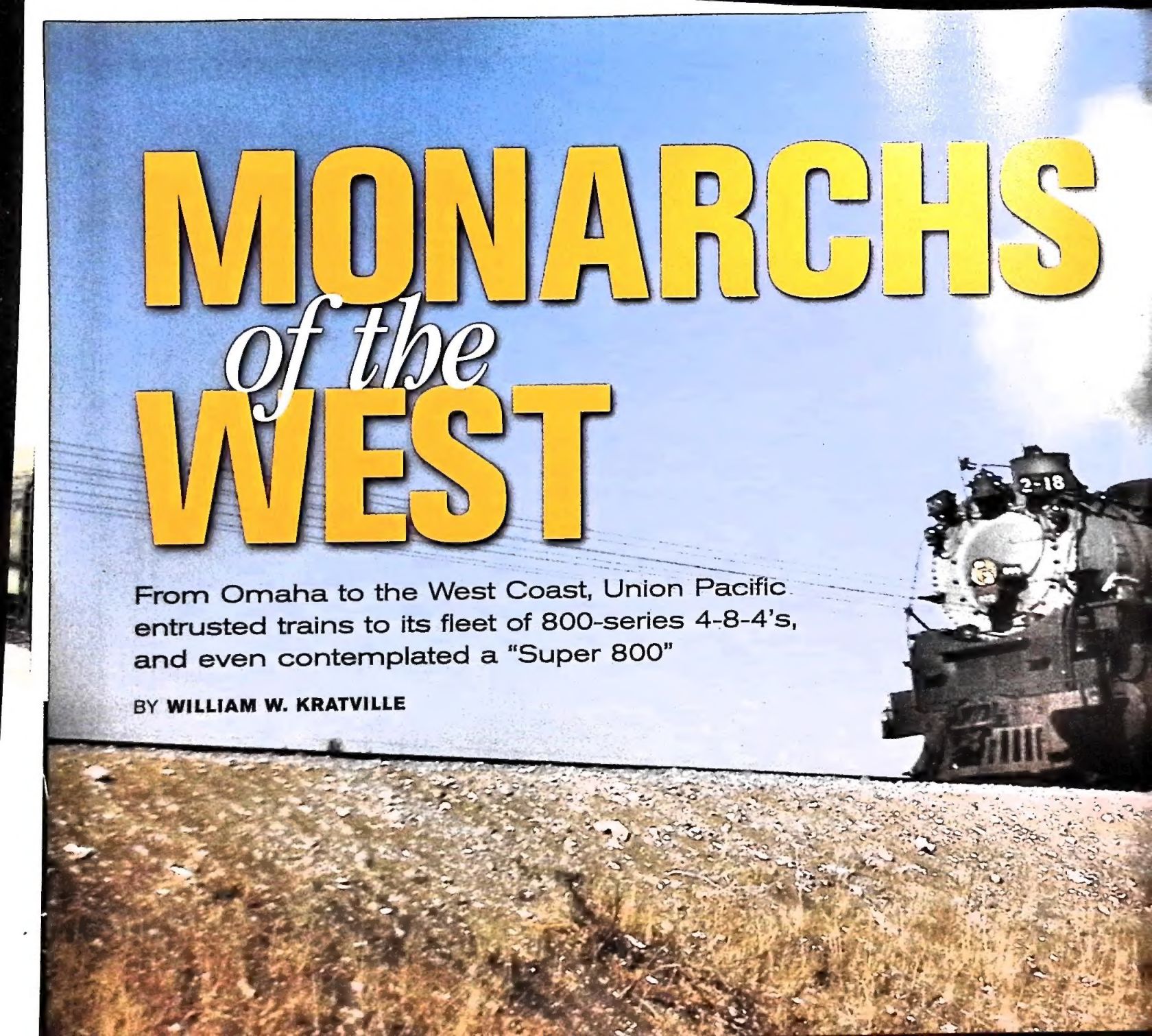
MONARCHS *of the* WEST

From Omaha to the West Coast, Union Pacific entrusted trains to its fleet of 800-series 4-8-4's, and even contemplated a "Super 800"

BY **WILLIAM W. KRATVILLE**



was designed large enough to enable easier flue and front-end work.

Although UP's 4-8-2's carried road numbers in the 7000 series, the 20 new 4-8-4's began at 800 because low numbers fit with Jabelmann's penchant for modernization. The class was officially listed as FEF-1 (Four-Eight-Four, first group), the proud road refusing to use "Northern" because of its association with the Northern Pacific. (UP also called its Santa Fe types TTT's!)

The FEF-1's were not filled with "firsts" on the UP, but followed proven Alco design. Their 77-inch drivers and smaller overall size relative to subsequent FEF's led the original group to become known as "little 800's."

The original assignments included handling the *Challengers*, *Overland Limited*, *Los Angeles Limited*, *Pacific Limited*, *Portland Rose*, and *California Fast Mail*. The longest runs were from Omaha to Ogden, Utah (990 miles), Salt Lake City (1026 miles), and Huntington, Ore. (1394 miles).

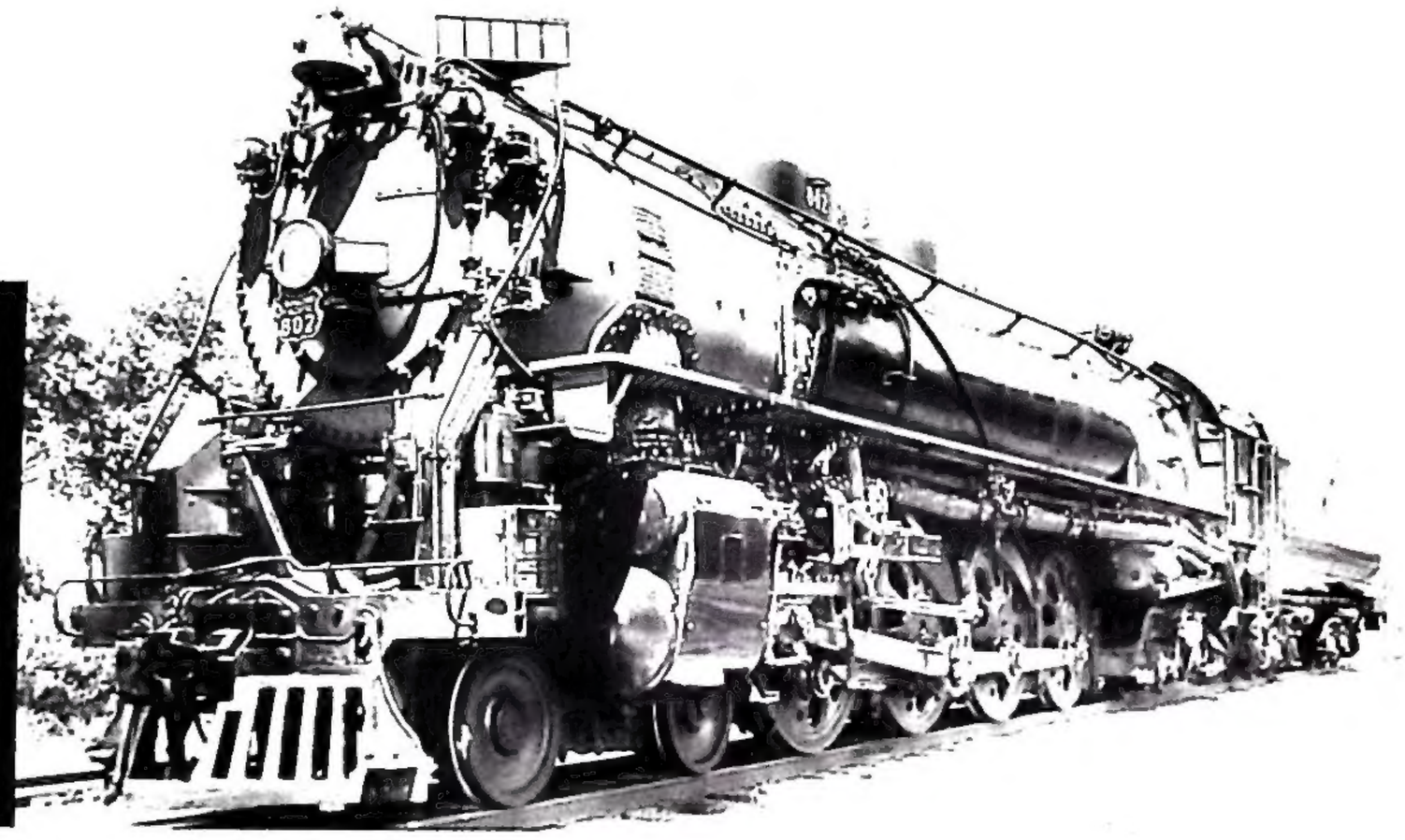
In train performance the new locomotives proved even better than anticipated. The success of the type proved to the road that Alco's initial warning that a 4-8-4 could not run fast due to piston thrust fears was unwarranted.

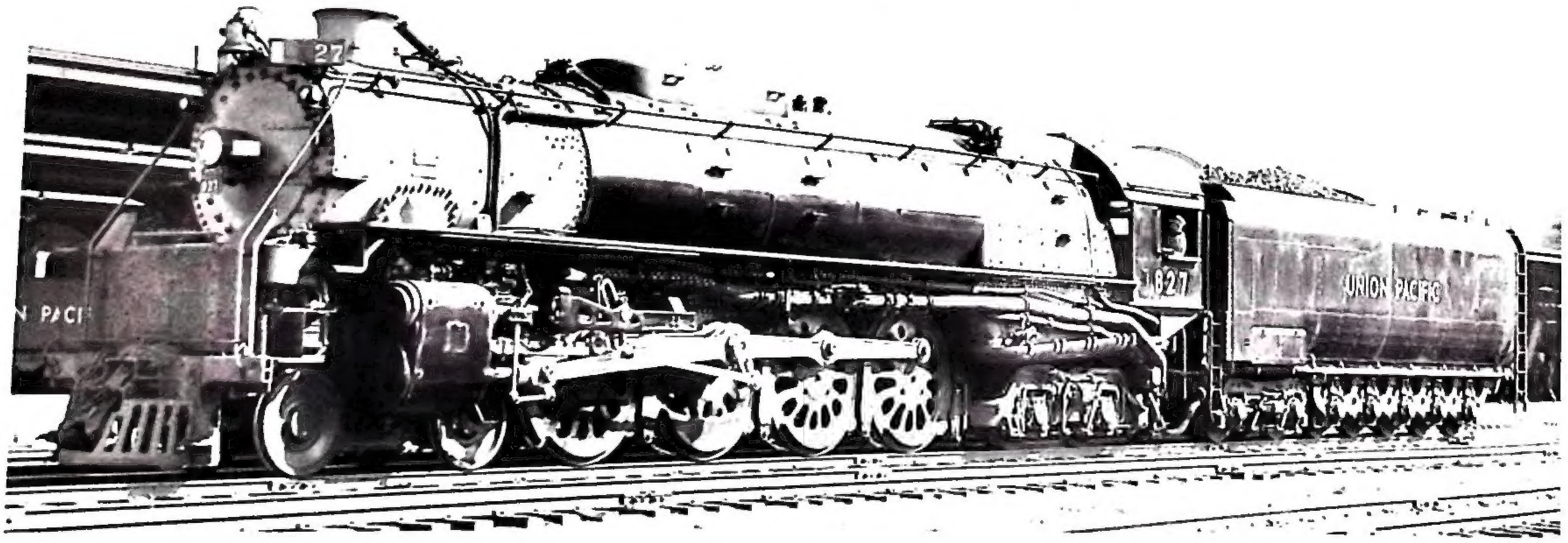
FEF-2: JABELMANN'S OWN

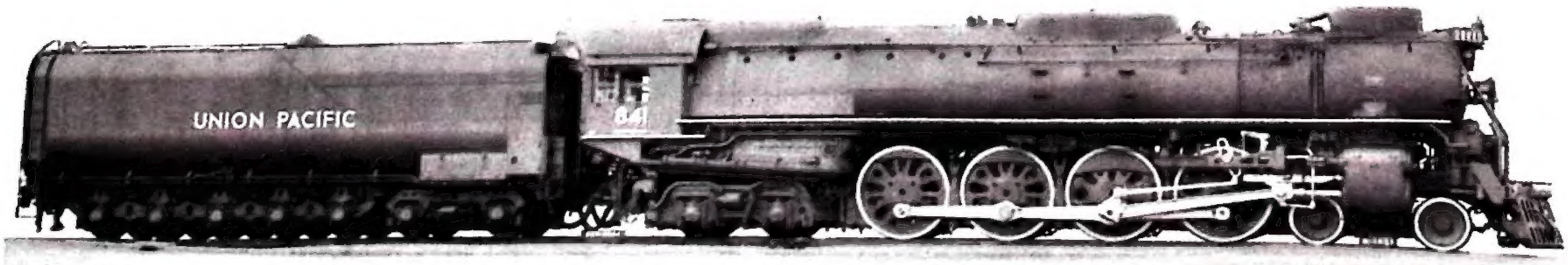
Thanks to the success of the FEF-1's and a desire to further the economies to more runs, UP management approved further passenger-power additions in 1938. Designed by Jabelmann's group, the new power would, as part of his broad program of standardization and improvement, incorporate several advances over the little 800's.

Passenger power was always desired to be in place by early summer, so the design team quickly evaluated the FEF-1's performance and design faults. Actually, much of the work had been done by the group in continual testing, particularly in front-end designs influenced by Leonard Botteron, a designer enamored of the idea of "opening up" locomotives to reduce back pressure.

FEF's, as built: No. 802 shows the original FEF-1 look of twin pump shields, 77-inch drivers, 12-wheel tender. FEF-2's like 827 had a single, full-width shield, combined sand and steam dome, 80-inch drivers, and centipede tender. The 841 has the FEF-3's double smokestack and beefier GSC pilot. Later, some engines got full-width pump shields, twin stacks, and big tenders; all received smoke "wings" and Mars warning lights.







TOP, RAIL PHOTO SERVICE; MIDDLE, RICHARD KINDIG; BOTTOM, ALCO

ROBERT HALE

Flying up Wyoming's Sherman Hill in the mid-1950's, FEF-1 815 carries in her numberboards the identity of the train she's helping: 101, the westbound *City of San Francisco.*

The new FEF-2's retained the large smokebox door of the little 800's, but many other items were completely redesigned by necessity, such as rods, or desire, such as larger tenders. The latter was a new UP design utilizing a cast bed with 10 wheels for the water load and a 4-wheel truck for stoker and coal loads. The early 4-8-4's often ran short on water, and the new 14-wheel "centipede" tender increased capacity.

The FEF-2's also featured 80-inch drivers, which were better for long, fast running. Cylinder diameter was increased to 25 inches, but the 32-inch stroke was retained. The General Steel Castings drop-coupler pilot introduced on the FEF-1's had proved effective and was retained. Overall, the 15 new 800's, received from Alco in 1939, were longer and heavier than the little 800's. Nos. 820-834 were designed for 120 mph, although continuous maximum horsepower was provided at 90 mph.

The 820's came with four-port nozzles in the front end below a single stack of 26½-inch diameter. Hollow pistons were used to reduce reciprocating weight while retaining strength.

For water delivery, the new 4-8-4's utilized the exhaust steam injector with the check valve located on top of the boiler to supply water downward for better heat transference. The larger MB model stoker replaced the BK models used on the 800-819. Also, force-feed lubrication was installed on almost any point subject to movement. Another improvement was the use of the Alco lateral springing device on the drivers.

From the start, the big 800's were plagued with smoke problems. As one top mechanical engineer later said, "Everyone knew what the problem was—Botteron had opened up the locomotives too far." This led to the addition of large sheet-metal smoke "wings" beginning in 1945. Eventually, the little 800's got the wings as well.

FEF-3: WAR BABIES

UP's last series of 4-8-4's came from Alco in 1944 following a government directive to all western roads to prepare for a 25 percent increase in business as the war effort swung to the Pacific. The 10 engines, classified FEF-3 and numbered 835-844, were virtually identical to the 820's, though material shortages necessitated heavier rods and other items. Most noticeable changes were a double smokestack and a cast pilot with enclosed coupler pocket.

Even though Otto Jabelmann is best known for his super steam designs on the UP, he had long been a believer in diesel power, even to preparing a dieselization plan as early as 1942. In fact, the only reason the 1944 4-8-4's (and the last Challengers and Big Boys) came was the war situation—Jabelmann would never have recommended more steam had the need for more motive power not been so pressing; he wanted diesels, but wartime production restrictions made them unavailable. In addition, UP was internally divided on its motive-power future.

Several factors entered into the steam-vs.-diesel debate. One was that Jabelmann had led a dual career with the UP. He had risen in the ranks of steam designers, but also was a major figure in the original Streamliner lightweight diesel passenger-train program of the 1930's. Thus he had been exposed to the efficiencies and performance of diesels. The other major influence was the road's president, William M. Jeffers, a died-in-the-wool steam devotee.

Aware of the performance of the Electro-Motive FT demonstrators on

In the early '50's, FEF-2 820 pulls out of Denver Union Station with train 9, carrying cars for L.A. and San Francisco. Across the platform is CB&Q's famous *Pioneer Zephyr*, assigned to a Denver-Cheyenne run at the time.

FEF-1 803 and an SP E7 rub elbows outside Los Angeles Union Passenger Terminal in the late '40's as they wait to back down onto their respective trains. The diesel is for the *Golden State*; 803 will likely haul the *Los Angeles Limited*.

TOP, RON PALMQUIST; ABOVE, HERBERT JOHNSON

their 1939-40 tour, Jabelmann felt that an acceptable diesel freight locomotive was at hand. It was under these circumstances that Jabelmann told his top aide to develop a dieselization plan. It was an earnest effort to plot a course for the road's locomotive progress the moment the war ended.

However, Jeffers was on a different course, and when Jabelmann's plan was introduced it was met with a less than enthusiastic reception. Jeffers' response amounted to, "Go back and draw up a better steam locomotive!"

SUPER 800'S, 1942 VERSION

Thus, in 1942, Jabelmann directed his staff to began work on a better, dual-service steam design. As an aside, he also said, "We know were going to diesel after the war, but we have to lay out a steam proposal too."

First the existing locomotive fleet was reviewed and the decision to go with a 4-8-4 rather than an articulated was made, because an articulated would be costlier to maintain and total lengths would be difficult to accommodate systemwide without turntable and roundhouse expansions.

The emphasis was on keeping with the Jabelmann theory—standardize to the fullest to achieve the lowest possible maintenance and operating costs. In line with this thinking was a thorough evaluation of all items then in use on the road's modern power.

The new power did not necessarily have to be bigger, but it did have to be better. However, the demands of freight consists were not the same as those of passenger trains. So to be a dual-service type as desired by Jeffers, boiler size and efficiency were critical to sufficient steam supply.

It was found that the most efficient boiler on the UP was that used on the FEF-2's and 3's. Although calculations were developed for larger boilers, the final conclusion was that the boiler would be sufficient if the firebox could be slightly increased in size and the combustion chamber given enough size to allow efficient gas travel.

'The King of wheel arrangements'

NORTHERN PACIFIC A-2 CLASS 4-8-4 2651, WESTBOUND AT VALLEY CITY, N.DAK.; LINN H. WESTCOTT PHOTO

Just as the 4-4-0 American type was the standard general-service locomotive for most of the 19th century, the 4-8-4 filled that role from the late 1920's until the end of steam. Northern Pacific got the first ones, built by Alco in 1926-27 for passenger service. NP gave its name to the type, though this was soon shortened to "Northern." (Several roads used alternate names, including Pocono [DL&W], Dixie [NC&StL], Greenbrier [C&O], Wyoming [LV], Potomac [RF&P], and Niagara [NYC].)

The Canadian National system, which ultimately had the largest 4-8-4 fleet (203, of the 1115 built), got its first ones in 1928, and considered them dual-service engines. Other roads followed suit, for the Northern had both the power for fast freights and the speed for passenger work. The four-wheel lead truck provided stability, and the four-wheel trailing truck allowed a large firebox for sustained steam production. The 4-8-4 found wide acceptance: the only major western road without them was the Texas & Pacific, while the only eastern roads lacking them were those with fleets of high-drivered 2-8-4's, the B&O, and the Pennsy. In the post-steam era, some of the most active excursion engines have been 4-8-4's.

George H. Drury, in his *Guide to North American Steam Locomotives*, described the 4-8-4 as "the ultimate development of non-articulated steam power." British author Brian Hollingsworth called it simply "the King of wheel arrangements."

HENRY R. GRIFFITHS JR.

Wearing the two-tone gray livery UP adopted for the FEF's in 1946, No. 818 wheels the *Portland Rose* up King Hill, east of Boise, in the early 1950's.

A larger firebox meant use of the MB stoker to assure adequate coal delivery to all locations in the firebox. The Northwest and South Central districts were oil territory, so the use of new power there would require some of the engines to be equipped as oil burners. Instead, any new power would go only to the Nebraska and Wyoming divisions, with some Challengers released for oil conversion and reassignment.

The smokebox size was not changed but there was many a debate over the exhaust system. For years the road had been experimenting with various front-end designs. Leonard Botteron's efforts to reduce back pressure by opening up the steam passages was taken a step

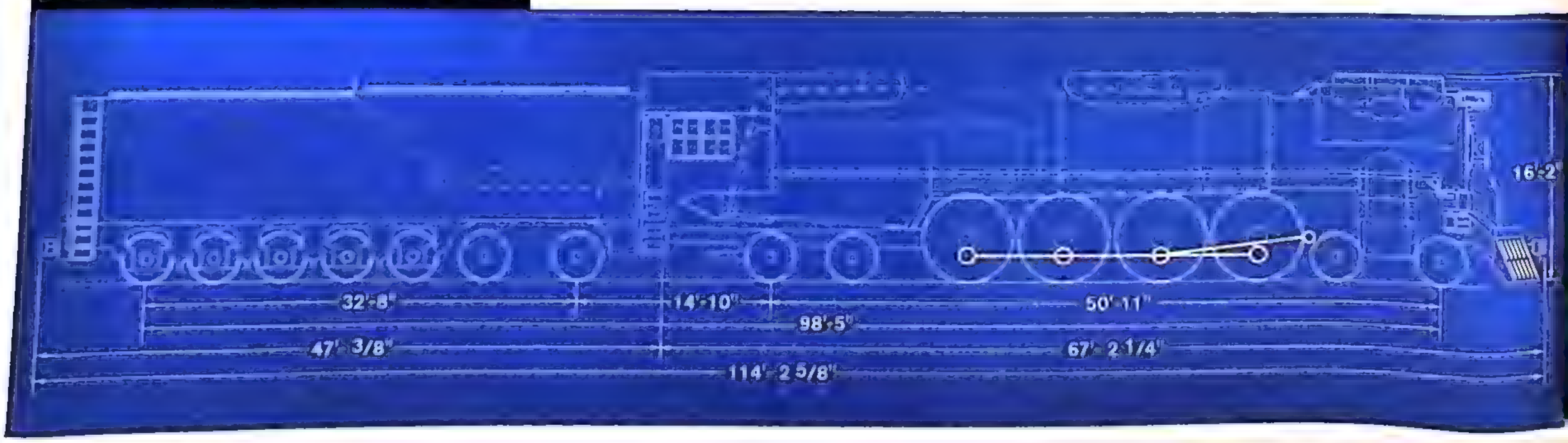
What would a Super 800 have looked like? Artist Gil Bennett gives an answer in this painting for STEAM GLORY of No. 867 with the second section of the *Utahn* above Buford on Sherman Hill in June 1948. Following UP drawings (like the side view below) and specs, he's created a machine with four stacks, poppet valves, and a vestibule cab. Like the FEF-2 and 3, the "FEF-4" would have had a 14-wheel centipede tender with a cast-steel frame (opposite page).

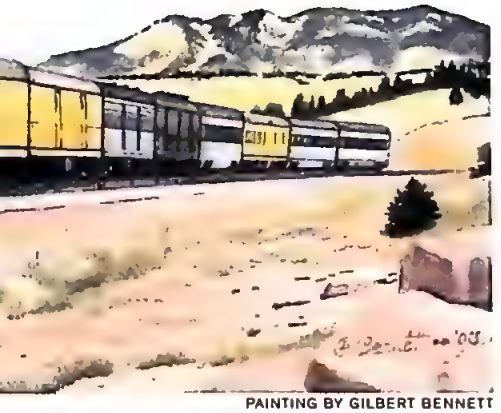
further, and the 1942 preliminary design proposed *four* smokestacks.

As with the existing 800's, frames and cylinders were to be integrally cast and no changes in size envisioned. The 80-inch driving-wheel size was retained in the interests of standardization and because no increase in speeds was anticipated.

The new engines would have Walschaerts valve gear with Franklin reverse gear. The throttle was of the front-end type. The pilot, trailing, and tender truck wheels were all of 42-inch diameter, the largest possible. All these features matched big 800 specs.

Jabelmann had long wanted the full use of roller bearings, a desire influenced by his study of Norfolk & Western practices. However, others in the





PAINTING BY GILBERT BENNETT

mechanical department had always thwarted his desire to fully utilize them. On the 1942 design, Jabelmann was at last able to specify roller bearings throughout.

The air-brake system would feature integral cast reservoirs and the compressors would be mounted on the pilot deck. Aftercooling would feature the Wilson sump design which eliminated the maze of piping common on most power. The team wanted to keep the general appearance clean.

The pilot was to be the latest version of the massive GSC retractable-coupler model. It had been found that the GSC (with gate closed) gave the best possible deflective protection in grade-crossing collisions.

A unique feature was to be a revolving light mounted on a bracket above the standard Pyle-National headlight. This "safety" light idea was initiated by the success of the Streamliner lighting and was to be activated by a pressure switch incorporated in the air-brake line, the relay being activated when an emergency application was made. The light would be red in emergency situations and white during normal use.

Two tender designs were considered. One would utilize a four-axle truck at each end, while the other would retain the famous "centipede" design. UP's Transportation Department did not like the centipede because of derailments caused by its longer rigid wheelbase, but the load factor was better with this design, so the individual-truck idea was discarded.

The use of a full vestibule cab was also discussed, but it was initially believed difficult to employ such a design because of clearance restrictions, so the idea was shelved.

The final design was a 4-8-4 with highly standardized parts, clean lines, and proven appliances and design. It would have developed approximately the same horsepower as the big 800's, but would operate more efficiently in both freight and passenger service.

When the calculations were finished, they were reviewed by Jabelmann and his staff and sent to Jeffers. By this time Jeffers was busy as the nation's wartime "Rubber Czar" and the plans went mostly unnoticed. They were finally filed away for "postwar projects." In the following year, 1943, UP lost its motive-power genius when Jabelmann died suddenly on a government trip to Britain.

SUPER 800'S, 1945 VERSION

The super 4-8-4 project was revived in August 1945, as the war was almost over and the builders had begun directing their efforts toward diesel production. Jeffers was preparing to step down but still was very much in command, so the steam ideas were pushed to the top of the list as "designs for a new high-speed freight locomotive."

The initial step was to roll out the 1942 specs. A larger firebox was laid out with a larger boiler and the smokebox dimensions increased correspondingly. All this required a longer frame, increasing total engine length. Adjustments would have to be made in certain terminal and mainline curvature.

Boiler tube and flue quantities had been virtually reversed in the FEF-3's of 1944, resulting in a net loss of evaporating and superheat surfaces. The new power would again reverse the flue-tube quantity to allow greatest possible evaporative surface. The MB stoker was retained and additional arch capacity incorporated. The combustion chamber was redesigned for the larger boiler and firebox values.

Boiler efficiencies were to be aided by use of the Type A superheater, which had proven easier to maintain than the Type E. Water delivery was to be through a Worthington SA unit, found to be successful on the 835's.

The net effect of the changes would be to produce a locomotive with adequate steam supply for the service intended. The GSC pilot would be used with the same arrangement for air pumps and aftercooling.

On the new design, a Canadian National short-type smoke wing was planned, as were overfire jets.

Steam admission was discussed, and the road had watched with inter-

GENERAL STEEL CASTINGS CORP.

GEORGE SPEIR

The 800's finished up on freights across Nebraska. Working a long stock-car train east near Kearney in September 1958 is a grimy 832.

est various attempts to employ poppet valves. UP's own poppet experience dated to 1929 and a stint with the Caprotti gear, the experiment ending in the usual problem of the gear not being able to withstand U.S. conditions.

There was much discussion over coal or oil firing, but with oil becoming more readily available at terminals, that fuel was preferred. This would eliminate the planned MB stoker and among other benefits would cut down on the annual prairie fire problem.

The full roller-bearing concept was retained because, besides the obvious maintenance factors, rollers would help reduce servicing times.

Another big improvement was to be a vastly extended network of lubrication for virtually all moving parts. The largest model force-feed lubricators were to be used along with steam heated lube lines wherever required.

During the war, new techniques had been employed in mechanical design and fabrication and the design team believed some should be utilized in railroad work. Among these was the expanded use of welding. The 1945 4-8-4's were to have welded flues.

The road had always experienced problems with cab comfort in winter storms, particularly in Wyoming, so an all-weather cab was designed. Because of the increased firebox size, the cab space was to be smaller, but it was felt that this would not be a problem because the latest cabs were more than generous, even for four men.

The already large sand box casing was to be increased slightly and provided with a pipe system to eliminate wet sand problems.

The headlight originally specified was the standard Pyle-National model, but sealed-beam designs were on the horizon and the UP held meetings with suppliers for possible furnishing of twin sealed-beam lighting, and twin units were shown on early sketches.

The centipede tender was used again, but with a "full top" design allowing 25,000-gallon capacity and 6000 gallons of oil.

In operation, no thought was given

UP's 4-8-4 family

Class	FEF-1	FEF-2	FEF-3
Nos.	800-819	820-834	835-844
Builder, year	Alco, 1937	Alco, 1939	Alco, 1944
Cylinders (in.)	24½x32	25x32	25x32
Boiler pressure (PSI)	300	300	300
Driver dia. (in.)	77	80	80
Tractive effort (lbs.)	63,600	63,800	63,800
Engine weight (lbs.)	465,000	483,000	490,700
Wheelbase	97 ft. 6 in.	98 ft. 5 in.	98 ft. 5 in.
Fuel (all changed to oil in 1946)	Coal	Coal	Coal
Tender	12-wheel	14-wheel	14-wheel
Fuel capacity (tons)	25	25	25
Water capacity (gals.)	20,000	23,500	23,500

to eliminating helpers on severe grades, but the new power was proposed to handle trains then headed by 2-10-2's and 4-12-2's at much higher speeds and at greatly reduced costs.

Under the new power plan, the Sherman and Ogden grades would be handed over to Big Boys and Challengers, the new locomotives being assigned Green River-Laramie and east of Cheyenne. Driver size was to remain at 80 inches and other wheels at 42.

Two numbering schemes were suggested. The most popular was sticking with the 800 series because it was not felt that many locomotives would actually be built. The other was starting with 900, but this was ruled out and the series assigned to new passenger diesels and older renumbered passenger units.

Even as the 1945 design was progressing, the builders came in with diesel proposals. Jeffers retired, and his successors did not share his faith in steam. After that, all steam efforts were pointed toward immediate, short-term economic improvements to existing designs, because it was thought that steam would vanish within a decade.

A GREAT LEGACY

A super 4-8-4 never came to pass on the UP, but the 45 FEF-1's, 2's, and 3's established a sterling record in passenger service all across the vast system. Enginemen loved them, particularly the second and third groups, ranking them as the best-riding and most comfortable power on the line. Even during slack periods, they were not assigned to freight work until the mid-1950's, when diesels took over more and more of their passenger assignments. They closed their careers on freights between Omaha and Cheyenne.

It is appropriate that No. 844, the only steam locomotive never to have been retired from a Class 1 railroad, still holds a slot on the UP roster. Decades after her sisters went cold, she is undergoing a major shopping at UP's Cheyenne steam shop, preparing for her 60th birthday and another 30 years of operation in excursion service. Even though he saw early on that diesels were the way of the future, Otto Jabelmann would be proud! ■

C W EDINGER

Thanks to mergers, excursion star 844 has gone places her sisters never imagined. In June 1997, she passed through Belden, Colo., on the soon-to-be-closed Tennessee Pass line of the old D&RGW.

Those gorgeous green 4-8-2's

A fine USRA design handled varnish until the end

BY **ED KING**

SOME LOCOMOTIVES worked their entire lives in the shadow of others.

In 1919, Southern Railway received 25 USRA light Mountain types, Nos. 1475-1499, class Ts-1. They went right to work in heavy passenger service on the Washington-Atlanta main line and the hilly Bristol (Tenn.)-Chattanooga-Atlanta and mountainous Knoxville (Tenn.)-Asheville-Salisbury (N.C.) routes.

The 4-8-2's had been on the property about a year when Southern decided that subsidiaries Cincinnati, New Orleans & Texas Pacific and Alabama Great Southern should gain their benefits. Engines 1495-1498 and 1475, respectively, became CNO&TP 6495-6499, and 1484, 1488, and 1489 were renumbered AGS 6692-6694.

Like all USRA designs, the light 4-8-2's were fine engines. Their quality derived from a superb balance of grate area, firebox volume, heating surface, cylinder diameter and stroke, and driving-wheel diameter. USRA's design team had been mandated to ignore individual prejudices and just design the best machinery possible within the required axle-load limits: 55,000 lbs. for the light locomotives, 60,000 for the heavies.

Not only were the USRA jobs fine performers, their designers wrapped them in attractive packages: handsome front ends with bell mountings at the top of the smokebox; centered headlights; front-end ladders; beautifully tapered boilers with good-sized sand domes spaced nicely between tapered smokestacks and compact steam domes; gambrel-roofed cabs; and equally well-proportioned tenders.

Like all USRA designs, Southern's light Mountains were fine locomotives.

Southern's class Ps-4 heavy Pacifics started arriving in 1923, and soon began to knock the Ts-1's off the glamorous mainline trains. More Ps-4's came in 1926—these were the first green Southern engines—and by the time the last arrived in 1928, there were 66 of them. The public's reception of the green engines was so great that Southern decided to paint all its passenger power green with gold striping, including the Ts-1's and the earlier Ts class.

The Ps-4's weren't for the mountains, though, and that's where the Ts-1's found their homes. They were just the thing for the Asheville Division, working not only to Salisbury but also on the Saluda line to Spartanburg, S.C. They went west to Knoxville, and for a time ran between Spartanburg and Knoxville with a quick servicing at Asheville. The Knoxville Division knew them well; they continued to run to Bristol and Chattanooga, and from Chattanooga to Atlanta. They also took over the Birmingham Division line between there and Atlanta and even occasionally ran from Atlanta to Macon.

The Mountains worked beside the Ps-4's on the AGS and CNO&TP, but everywhere on the system, the Pacifics, with their classic lines, were the favorites.

The Ps-4's got the accolades, but as the years passed, the Ts-1's came and went in their less glamorous assignments just as dependably and just as beautifully. As a class, the Ts-1's were never downgraded to freight service, though at the very end of steam on the Southern a few were seen in that duty. In their hill-country work, the Ts-1's and their steamboat whistles preached the USRA gospel for 34 years. They spoke to the masses with sassy, cracking exhausts. They were loud, too—they weren't ever going to sneak out of town.

Here we see the 1477 on Knoxville-Bristol passenger train No. 4 in 1952. She's just as beautiful as she was when she received her first coat of green paint 26 years earlier, and she makes that lowly local look like a classy operation. But EMD passenger F3's kept coming, and sister 1486 closed out steam operation on the Knoxville Division on 4's counterpart, train 1, in January 1953.

Some steam fans wish we could've had a Ps-4 Pacific in excursion service instead of the beloved Mikado 4501. But wouldn't a Mountain type have been even better?

Yes, some locomotives worked their entire lives in the shadow of others. They shouldn't have. ■

EDWARD THEISINGER

Glorious in green and gold, Southern 1477 makes classy work of lowly local No. 4 at Mohawk, Tenn., on May 27, 1952. SR's 4-8-2's came from Baldwin (15) and Richmond (10).

FAST-FREIGHT *Articulateds*

A dozen railroads from coast to coast had success with locomotives that combined power, speed, and flexibility

BY **NEIL CARLSON**

J. DAVID INGLES

FAST FINISH: In the waning days of regular-service Union Pacific steam, Challenger 3708 rolls a merchandise freight west toward Cheyenne, Wyo., in June 1959.

THE "ROARING TWENTIES" served as a wake-up call to America's railroads. For years, the carriers had offered service on their own terms, but now they were faced with the need to become competitive. As highways improved, trucks began siphoning off time-sensitive merchandise. The perishables market (fruit, produce, meat) needed to be handled with special care and dispatch. Speed and service quality became important issues. Shippers would pay premium rates for this service, *if* it was delivered.

To be responsive, railroads would have to offer improved freight schedules with faster transit times. Freight-train speeds of up to 60 mph would be needed. Providing this service would require some new motive power, however, as the 2-8-2's and 2-10-2's in use were not up to the task.

In level territory east of the Mississippi River, the 4-8-2 type became the favored fast-freight engine. Most had 69-inch-diameter, or larger, driving wheels which moved the locomotive into the upper end of its horsepower curve at high speeds. Maximum output was developed at 45 to 55 mph. The large driver size also provided more room for counterweight than was possible with the 63-inch drivers found on older engines. This permitted smooth operation at higher speeds. With its extra axle to carry the weight, a 4-8-2 also could be built as a larger and more powerful locomotive than the 2-8-2 it replaced. These features were key to the 4-8-2's performance. In the late 1920's, the 4-8-2 was joined by the "Super-Power" 2-8-4 and 4-8-4 types, which also made fine fast-freight engines.

Topography in the West often precluded use of these types, however. Besides the obvious mountain grades, western railroads also traversed long stretches with moderate grades of 0.5 to 1.0 percent, coupled with gentle curves. A fast freight could operate for hours over these routes at track speeds. Unfortunately, the grades were beyond the capability of eight-coupled engines, which lacked the necessary power and adhesion. Consequently, doubleheading or reduced train size remained the options, and neither was attractive. The western roads really needed a new and more powerful locomotive especially designed to move fast freights

LINN H. WESTCOTT

PREDECESSOR: UP's 4-12-2's first addressed the need for a fast freight engine in the West's wide-open territory, exemplified by 9033 in Nebraska with empty reefers.

across undulating terrain.

Union Pacific was the first to address these requirements. Perhaps better than other western roads, UP understood the need for fast freight service. With its longer route to California, UP was at a competitive disadvantage versus rival Santa Fe. Further, UP was willing to underwrite the development of new and more powerful locomotives. The carrier historically had a close relationship with builder American Locomotive Co. (Alco), which had been promoting simple three-cylinder locomotives as the next generation of high-performance steam power. Beginning in 1922, Alco had begun delivering three-cylinder 4-8-2's to several railroads other than UP.

In 1925, UP received 10 three-cylinder 4-10-2's, with which it hoped to replace the slow Mallets and 2-10-2's on its main lines. The railroad quickly realized, however, that the 4-10-2 didn't have enough power for the job, so together with Alco, UP set about designing a still bigger three-cylinder locomotive: a 4-12-2.

The Super-Power steam concept was still in its infancy in 1926, yet many Super-Power features were incorporated in this new locomotive. The boiler was designed with both a substantial grate area and a long combustion chamber. It had the new Type E superheater, which produced steam with significantly higher levels of superheat than the older Type A design. The engine was equipped with a high-capacity feedwater heater. Driver diameter was 67 inches; this was an attempt to match the 69- to 70-inch size on the 4-8-2's, but the size was limited by the need for the last driving axle to help support the firebox. Lateral-motion devices were applied to the front and rear axles in an attempt to allow the locomotive to negotiate sharp curves. The first 4-12-2 was delivered in April 1926, and UP liked what it saw —it ordered 87 more, with the last one coming in 1930.

The railroad tried its 4-12-2's, which became known as the Union Pacific type, on several regions. They were deemed too rigid for use on curving lines such as the one through the Blue Mountains of Oregon, but they found a ready home on UP's main lines across Idaho, Wyoming, and Nebraska.

THE PROMISE OF ARTICULATION

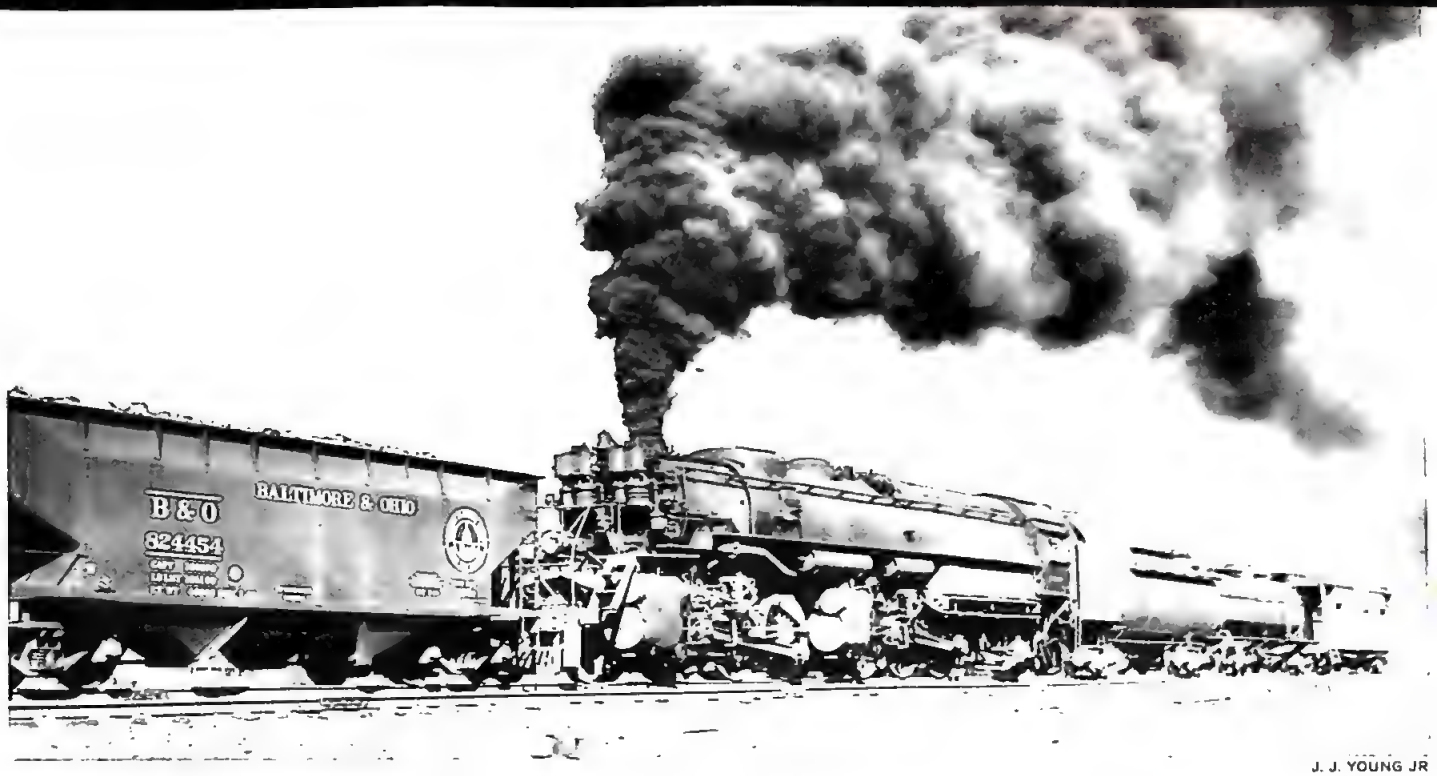
Union Pacific was perhaps the only road that could effectively employ 12-coupled power on its lines, so the needs of the other carriers were still unmet. It would ultimately take a locomotive with high adhesion, great power, and *flexibility* to do the job. During the 1920's, the development of the articulated locomotive had taken a giant step forward. New technology had moved the articulated from the slow and lumbering compound Mallet into a single-expansion locomotive with high adhesion and reasonable speed capability.

Given the success of these locomotives, it was just a matter of time before an articulated was configured as a fast-freight locomotive. With two sets of six-coupled drivers, it would have about the same adhesion and power as a 4-12-2, but being articulated, it would also have the required flexibility. Surprisingly, the first attempt at such an engine was not by a western road but by the Baltimore & Ohio.

In 1930 Baldwin built two experimental 2-6-6-2's for the B&O. The railroad had not yet taken the plunge into high-speed freight service, and 2-8-2's and 2-10-2's were still its standard freight power. B&O was, however, looking for a new fast-freight engine that could roam its entire system, and the two 2-6-6-2's were intended as the first of a fleet to fill this need. Significantly, they were the first articulateds equipped with 70-inch drivers.

B&O tested the pair on its traditional proving ground, the east end of its Cumberland Division. While the 2-6-6-2's were more than capable of outperforming B&O's 2-10-2's, a fatal flaw in their design also became evident. At speed, the front engine became unstable. Since this was at the onset of the Great Depression, B&O made no serious attempt to remedy the problem, and the two locomotives were used in low-speed freight service until replaced by diesels in 1953.

During the early Depression years, locomotive development was forced to a standstill, but it slowly resumed in



J. J. YOUNG JR

PIONEER: B&O's two 1930 2-6-6-2's were the first articulateds with 70-inch drivers, though a design flaw soon confined them to low-speed service. On March 6, 1948, 7400 helps a coal drag at Lansing, Ohio.

HOMER R. HILL

SUCCESS: Seaboard Air Line's 1935 Baldwin 2-6-6-4's were the first fast-freight articulateds that worked as intended. No. 2502 heads south at Raleigh, N.C., in 1941.

1934 as both Baldwin and Alco began to work on concepts to meet the need for heavy fast-freight engines. It was Baldwin that delivered the first successful fast-freight articulated, to the Seaboard Air Line in 1935.

Seaboard has been compared with the Nickel Plate Road, as both made every effort to compete with a fast-freight operation. But NKP's Chicago-Buffalo route was relatively flat, hence its eventual reliance on 2-8-4's, whereas SAL's single-track main between Richmond, Va., and Raleigh, N.C., had a hill-and-dale profile which limited the tonnage that could be handled by its 4-8-2's and 2-8-2's. This was in contrast to Seaboard's rival to the east, Atlantic Coast Line, which had a double-track main line with the profile of a pool table. SAL was having trouble keeping its main line fluid and turned to Baldwin for a new fast-freight engine. The builder proposed a locomotive of the 2-6-6-4 wheel arrangement. The year before, Baldwin had built three locomotives of this type for Pittsburgh & West Virginia, for coal-drag service. The Seaboard 2-6-6-4's, however, would be for fast freights.

Seaboard received five 2-6-6-4's in 1935. They had 69-inch drivers and an amply proportioned boiler, yet were relatively small locomotives, weighing about the same as a modern 4-8-4. This was necessary to keep the weight within SAL's specification for a maximum axle loading of 55,000 lbs. The 2-6-6-4's were designed according to Super-Power concepts. For their size, they had a large grate area, a long combustion chamber, three thermic siphons in the firebox and combustion chamber, a Type E superheater, and other modern appliances. Further, the ability of the four-wheel trailer truck to fully support the firebox allowed a deep design that could be positioned behind the rear drivers. This gave the firebox greater furnace volume, necessary for complete fuel combustion.

Baldwin was aware of the instability problems of the B&O 2-6-6-2's, and the Seaboard 2-6-6-4 boiler was designed with a 24-foot tube length and a 72-inch combustion chamber, which had the effect of moving the locomotive's center of gravity forward, thereby shifting weight to the front engine. The SAL 2-6-6-4's did not suffer from stability problems. They performed as expected, handling 50 percent more tonnage than the 4-8-2's they replaced while keeping the same schedules. Seaboard went back to Baldwin for five more in 1937, and all stayed in mainline service until 1947, when diesels arrived. They then got a second life, as all 10 were sold to the B&O, for whom they operated until 1953.

ALCO AND U.P. COME UP WITH THE CHALLENGER

Union Pacific, meantime, while satisfied with its 4-12-2's, still wanted a

The Super-Power formula

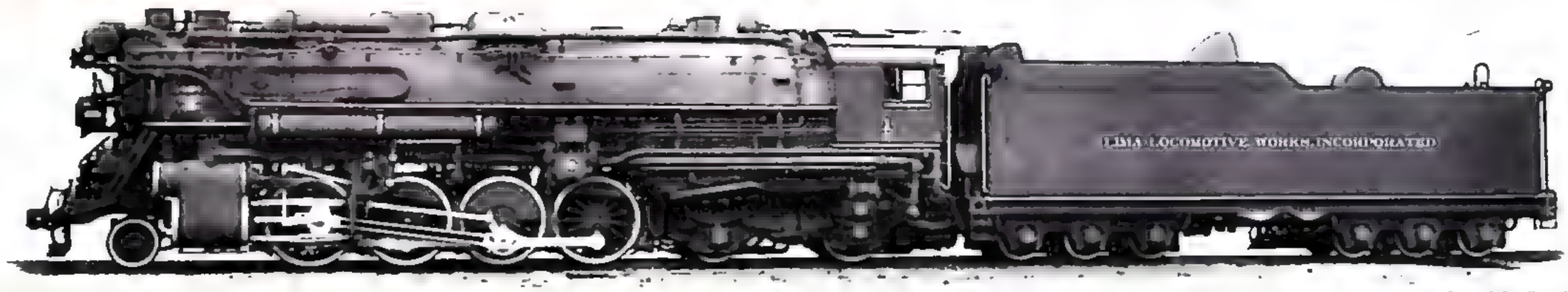
In the early 1920's, railroads began to recognize that speed was as important as locomotive efficiency in freight service. The railroads and locomotive builders tried various approaches to the problem, including high-pressure boilers, three-cylinder locomotives, articulation, watertube fireboxes, and just plain bigger locomotives. Lima Locomotive Works' Chief Engineer William E. Woodard looked at boiler capacity. In 1922 Lima built an experimental 2-8-2 based on New York Central's H-7. Among the differences were a larger grate area, an improved superheater, an Elesco feedwater heater, larger cylinders, lighweight rods, and a booster on the trailing truck. The locomotive, Michigan Central H-10 No. 8000, weighed only 6000 pounds more than NYC's H-7, but could outpull the H-7 while burning less coal.

The H-10 was a prelude. Woodard saw that sustained power output depended not on boiler pressure, weight on drivers, and driver and cylinder dimensions, but on the capacity of the boiler to generate steam. That required grate area. More steam requires more fire, and more fire requires more fuel–but that fuel must burn to produce heat. If it is piled deep in a small firebox, it will not burn completely but instead go out the stack as black smoke.

The H-10's firebox, with 66.4 feet of grate area, was at the limit of what a 2-wheel trailing truck could carry. Woodard added an axle to the trailing truck to support a 100-square-foot grate, creating the 2-8-4 wheel arrangement. Other specs: 28x30-inch cylinders, 63-inch drivers, 65 percent cutoff, 240 psi steam pressure. Built in 1925, the new locomotive was numbered 1 and given a class designation of A-1 (photo below). The A-1 demonstrated on eight railroads before joining Illinois Central's roster.

Woodard's "Super-Power" concept became the basis for Lima's innovations during the next two decades, which included C&O's high-drivered 2-10-4's, the modern 2-8-4's of such roads as the Nickel Plate and Pere Marquette, and the 2-6-6-6's. The other two major builders (Alco and Baldwin) and most railroads embraced the concept, and locomotive development until the end of steam was based largely on Super-Power principles.

Excerpted from *Guide to North American Steam Locomotives,* by George H. Drury (Kalmbach, 1993 and '97).



LIMA LOCOMOTIVE WORKS

R. V. NIXON

RICHARD H. KINDIG, NEAL R. MILLER COLLECTION

NEWCOMER: Just a year old, UP Challenger 3904 moves the eastbound 17-car *San Francisco Overland Limited* at 30 mph just east of Hermosa, Wyo., on July 18, 1937.

fast-freight engine that could be used throughout its system and go faster than the 4-12-2's top speed of 50 mph. So in 1934, UP and Alco began a collaborative effort to design a new heavy fast-freight locomotive. Both were sure that a single-expansion articulated was the answer. Also aware of the instability problem of B&O's Baldwin 2-6-6-2's, the Alco-UP team took a different approach, settling on a four-wheel lead truck, known for its stability at speed.

The resulting new locomotive became a 4-6-6-4. As with the Seaboard Baldwin 2-6-6-4, Alco shifted the boiler forward to move weight onto the front engine. However, with the slightly longer wheelbase, Alco chose to have the firebox supported by both the trailer truck and the last driving axle. Compared with the 2-6-6-4, the resulting locomotive had a long and shallow firebox. These 4-6-6-4's were also built to Super-Power standards, with powerful boilers and modern appliances; driver diameter was 69 inches.

The first 15 4-6-6-4's UP received, in 1936, performed well. During trials, a UP official gave the name "Challenger" to the new type. The next year, UP acquired 25 more, including 6 equipped for passenger service. After delivery of the first 40 Challengers, UP took a greater hand in the design process and during the war years of 1942-44 acquired 65 more, built to UP design.

COPIES: Spokane, Portland & Seattle's Challengers were oil-burning versions of Northern Pacific's; Z-8 911 was westbound near Marshall, Wash., May 17, 1953.

UP's 105 Challengers roamed its main lines from Omaha to the Pacific coast, and some of those assigned to the West were converted to oil-burning. UP's Challengers were active until the very end of steam on the system, in summer 1959. Two are preserved, including the 3985, which UP operates in excursion service.

In 1935 another western road, Northern Pacific, was also considering new power. Its chief competitor, Great Northern, had the better route to the Pacific Northwest, which had forced NP to be a motive-power innovator in order to have competitive schedules.

NP, which had bought the first mainline 2-8-2's, the first 4-8-4's, and the first 2-8-8-4's, now was looking for a new high-speed freight locomotive that could handle 4000-ton trains on its main line west of Livingston, Mont. The route included two mountain passes plus many miles with grades of up to 1 percent. Doubleheaded 2-8-2's were the rule, with helpers added for the two summits, and NP wanted an engine that could eliminate doubleheading and boost train speeds. The summits would still need helpers.

With information supplied by UP and Alco, NP's mechanical department set about designing a new 4-6-6-4 to meet its needs. A major difference on NP was the need to burn sub-bituminous coal from on-line mines. This fuel had less heat value than the coal used by other roads, and burning it required a substantially larger grate than normal. NP's Challengers would have a grate of 152 square feet versus 108 on the first UP examples. NP's other specs were from the Super-Power handbook: powerful boilers, 69-inch drivers, and modern appliances, including three thermic siphons in the firebox and combustion chamber. NP asked for bids on 12 locomotives, and Alco was the winner; they were delivered in 1936. After some initial teething problems, the new class Z-6's settled down, and NP was pleased with the results. Less than a year later, in 1937, NP took another 9, and their territory was extended to Spokane, Wash. NP said these 9 Challengers replaced 27 2-8-2's.

In 1937, Alco built six more Z-6 Challengers for NP's half-owned (with GN) subsidiary Spokane, Portland & Seattle. They were identical to the NP 4-6-6-4's in every respect but one—they were oil-burners. SP&S used them in fast-freight service on its main line between Spokane and Vancouver, Wash.

Just before and during World War II, NP took 26 more Challengers, classes Z-7 and Z-8. Internally their boiler, cylinder, and valve specifications were similar to the Z-6. The chief differences were an increase to 70-inch driver diameter and a corresponding increase in boiler pressure. Exterior differences, however, were significant. The new locomotives had solid steel pilots, all-weather cabs, and large

SWIFT GIANTS: FAST FREIGHT ARTICULATEDS COMPARED

Railroad	UP	B&O	UP	UP	WP	D&H	CRR	NP	SP&S	D&RGW	WM	SAL	N&W	C&O	VGN	UP
Class	UP-1 to UP-5	KK-2	CSA-1	4664-3	M-100	J-95	E-1	Z-6	Z-6 [2]	L-105	M-2	R-1	A	H-8	AG	4884-1
Type	4-12-2	2-6-6-2	4-6-6-4	4-6-6-4	4-6-6-4	4-6-6-4	4-6-6-4	4-6-6-4	4-6-6-4	4-6-6-4	4-6-6-4	2-6-6-4	2-6-6-4	2-6-6-6	2-6-6-6	4-8-8-4
Road numbers	9000-87	7450	3900-14	3950-69	401-07	1500-19	650-57	5100-11	900-05	3700-09	1201-12	2500-04	1200-09	1600-09 [3]	900-07	4000-19
Builder	Alco	Baldwin	Alco	Alco	Alco	Alco	Alco	Alco	Alco	Baldwin	Baldwin	Baldwin	N&W	Lima	Lima	Alco
Year built	1926,'29,'30	1930	1936	1942	1938	1940	1942-43	1936	1937	1938	1940-41	1935	1936-37	1941	1945	1941
Cylinders:																
Bore x stroke (inches) [1]	27x32, 27x31	23x30	22x32	21x32	22x32	20½x32	22x32	23x32	23x32	23x32	22x32	22x30	24x30	22½x33	22½x33	23¾x32
Driver diameter (inches)	67	70	69	69	70	69	69	69	69	70	69	69	70	67	67	68
Boiler:																
Pressure (psi)	220	250	255	280	265	285	265	250	250	255	250	230	300	260	260	300
Grate area (square feet)	108.25	92.3	108.2	132.2	108.2	108	108	152.3	152.3	136.5	118.8	96.3	122	135.2	135.3	150.3
Fuel	bit. coal	bit. coal	bit. coal	bit. coal	bit. coal	bit. coal	bit. coal	sub-bit. coal	oil	bit. coal	bit. coal	bit. coal	bit. coal	bit. coal	bit. coal	bit. coal
Combustion chamber (in.)	80½	67	90	106	86	94	94	89	89	109½	96	72	116	118	118	112
Tube length (feet-inches)	22-0	25-0	22-0	20-0	23-0	22-0	22-0	23-0	23-0	22-0	23-0	24-0	24-1	23-0	23-0	22-0
Syphons	none	2	none	none	3	none	none	3	3	3	5	3	none	3	3	none
Heating surfaces:																
Evaporative (square feet)	5853	6471	5381	4795	5666	5389	5392	5832	5832	6341	5770	5513	6650	7240	6795	5889
Superheater (sq. ft.; type)	2560; E	2900; E	1650; A	2162; E	1724; A	1681; A	1680; A	2114; A	2114; A	2628; E	1735; A	2398; E	2703; E	3186; E	2922; E	2466; E
Weights in working order:																
On drivers (lbs.)	355,000	373,000	386,000	404,000	399,000	406,500	420,000	435,000	436,000	437,939	402,266	330,000	432,350	507,000	495,000	540,000
Locomotive (lbs.)	495,000	466,000	566,000	627,000	590,000	597,000	607,000	624,500	621,000	641,900	601,000	480,000	573,000	778,000	753,000	762,000
Tender (lbs.)	287,000	273,000	310,000	348,500 [4]	401,500	389,100	316,900 [4]	398,500	393,700	394,000	338,250 [4]	301,300	378,600	426,100	442,000	435,800
Rated tractive force (lbs.)	96,650	90,000	97,400	97,350	99,600	94,400	101,120	104,500	104,500	105,000	95,500	82,300	114,000	110,200	110 200	135,375
Factor of adhesion	3.67	4.14	3.96	4.15	4.00	4.31	4.15	4.17	4.17	4.17	4.21	4.01	3.79	4.60	4 49	4 00
Tender capacity:																
Fuel	21 tons	20 tons	22 tons	28 tons	25 tons	26 tons	26 tons	27 tons	6000 gal.	26 tons	30 tons	24 tons	30 tons	25 tons	25 tons	28 tons
Water (U.S. gallons)	15,000	18,000	18,350	25,000	22,000	22,500	22,500	20,000	20,000	20,000	22,000	16,000	22,000	25,000	26,500	25,000

Notes:

1. All locomotives have four cylinders of identical dimensions except UP 4-12-2, which has three: two 27x32 in. and one 27x31 in.
2. SP&S class Z-6 was an oil-burning version of the NP Z-6
3. C&O 1600-09 were the heaviest reciprocating steam locomotives built; C&O 1610-1659 weighed less.
4. Weight of tender two-thirds loaded

DOUG KOONTZ

TEACHER: Thousands of people could see what fast-freight articulateds were all about after N&W restored A-class 1218 for excursions. In 1989, the 2-6-6-4 drifted through "the Loops" east of Asheville, N.C.

4-10-0 "centipede" tenders. The addition of these engines allowed NP to extend the Challengers' territory east to Glendive, Mont., and west to Yakima, Wash. In 1944, SP&S bought two more oil-burning versions of NP's Challengers, this time based on class Z-8. Because the NP Challengers' territory was ideally suited to diesel operation, they were early victims. By the mid-1950's, most were out of service, and none survives.

HOMEGROWN SUPERSTAR: N&W'S A

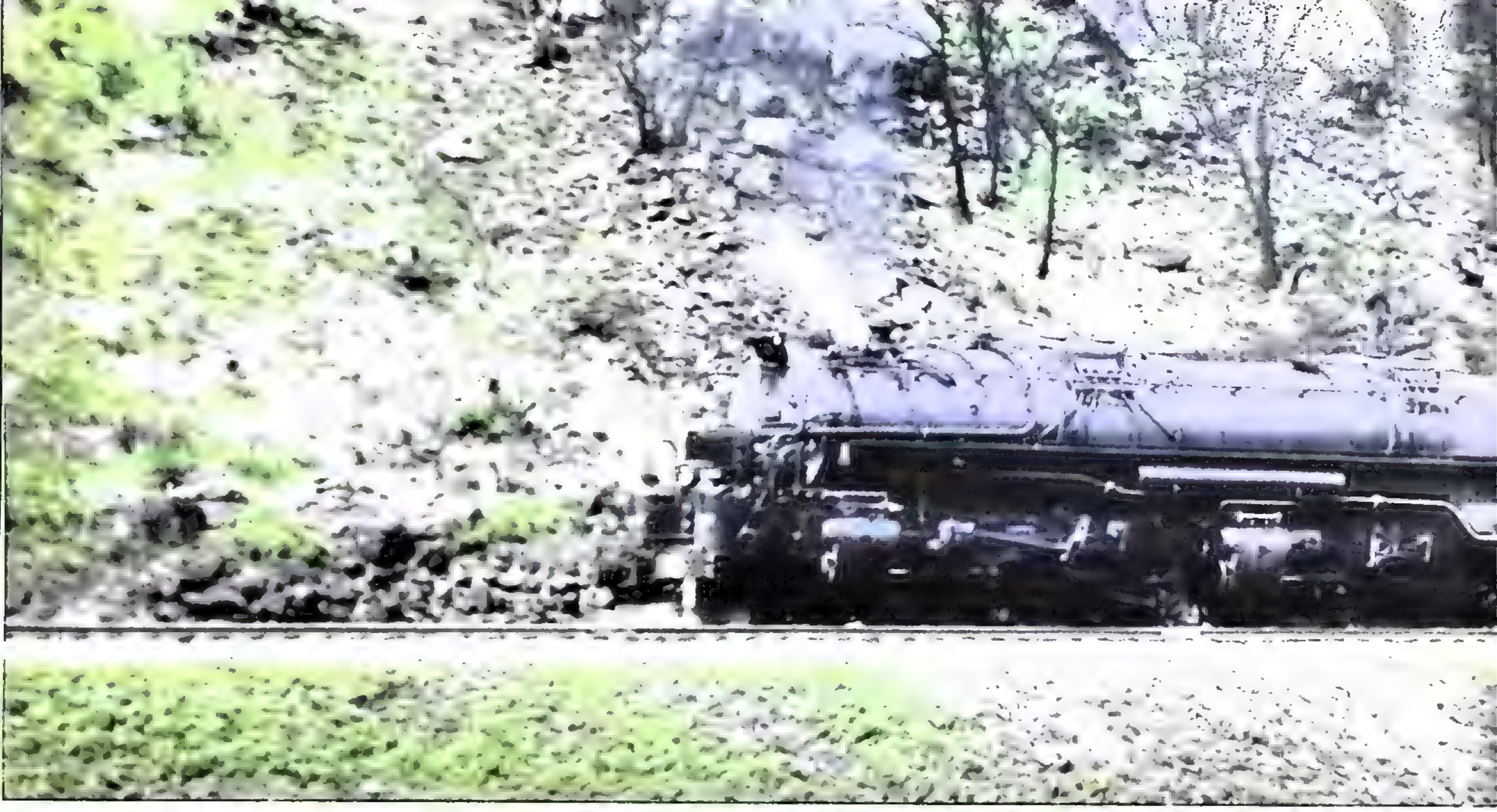
The year 1936 brought a third builder to the fast-freight articulated scene: Norfolk & Western Railway. Besides its substantial coal traffic, N&W also enjoyed a thriving merchandise business between Ohio and Virginia. In competition for this traffic, N&W was at a disadvantage to rival Chesapeake & Ohio, because N&W's crossing of the Appalachians was more difficult. In 1926 N&W had built in its Roanoke (Va.) shops 10 mammoth 4-8-2's intended to power fast freights, but the engines were a disappointment, and in the mid-1930's N&W watched as events unfolded at Baldwin and Alco and on the UP.

N&W's Mechanical Engineering office set about designing a new high-speed freight locomotive. Starting with the boiler, the engineering staff concluded that to obtain the desired power, their locomotive should have a deep firebox supported by a four-wheel trailer truck as Baldwin had done with the Seaboard locomotives. N&W had a lot of experience designing two-wheel lead trucks, and so had no worries about instability problems. With this decision, the wheel arrangement became a 2-6-6-4 instead of a 4-6-6-4. The new locomotive N&W developed was quite modern, including integrally cast steel frames and cylinders, plus

RICHARD H. KINDIG

OUT WEST: Rio Grande 3710, climbing Utah's Soldier Summit westbound at 25 mph on June 12, 1947, with two unseen helpers pushing, was the first of D&RGW's five Baldwin Challengers of 1942. Western Pacific used its 4-6-6-4's on the desert; the 403 is on Silver Zone Pass at Proctor, Nev.

RAYMOND C. HENRY



IN THE FOOT OF VIRGINIA: Southbound with 82 cars on May 28, 1952, Clinchfield Challenger 662 crosses Copper Creek viaduct high above a Southern Railway line.

roller bearings on all axles. It had the Type E superheater, a large grate and combustion chamber, 275 psi boiler pressure (later raised to 300), and 70-inch drivers. Designated class A, it was a Super-Power example in all respects.

Roanoke began delivery of 10 A's in May 1936, which were were put to work on N&W's main line between Columbus, Ohio, and Norfolk. After a few early problems, the A's settled into handling manifest freights plus the occasional coal drag. Two even hauled passenger trains on the Bristol (Va.) line until the railway's first 4-8-4's arrived. The A's were exceptional locomotives; once during trials, one produced 6300 drawbar horsepower. During World War II, Roanoke built 25 more A's, and then in 1950, a final 8. Many consider N&W's A to be the finest fast-freight articulated. The railway dieselized after most others, and the A's stayed active through the 1950's. One, the 1218, was restored in 1987 for excursion service and operated for seven years; it is preserved in Roanoke.

By 1937, the fast-freight articulated was an established concept, and other railroads became interested. The Chal-

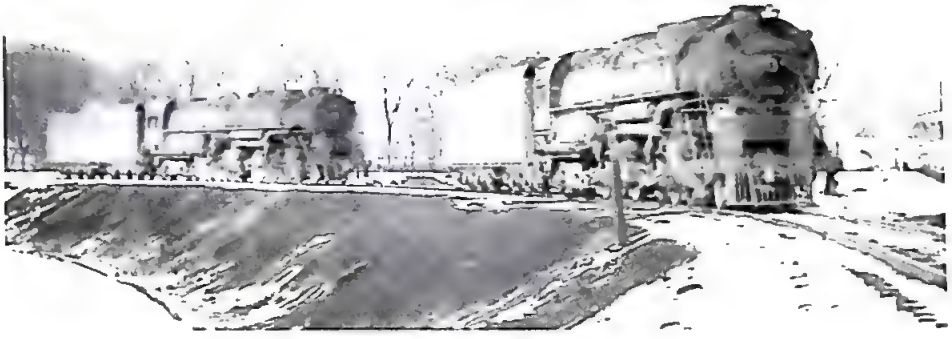
THREE PHOTOS EDWARD THEISINGER

WAITING: The crew on WM 4-6-6-4 1202 takes a breather as they wait for maintenance-of-way employees to finish work at Cumberland Narrows on May 15, 1952.

lenger type dominated, and Alco, then Baldwin, found new customers. Alco built upon its early 4-6-6-4 experience with UP and delivered 7 in 1938 to Western Pacific, 40 during 1940-46 to Delaware & Hudson, and a dozen to Clinchfield: 8 in 1942 and 4 in 1947 (the last Challengers built). While there were exterior differences among these other 4-6-6-4's, especially with D&H's, internally they were all based on the 1936 UP examples.

Western Pacific used its Challengers across the desert between Elko, Nev., and Salt Lake City, Utah, while D&H employed its 4-6-6-4's in manifest service between Binghamton and Mechanicville, N.Y., and in helper service over Ararat Summit to Wilkes-Barre, Pa. Clinchfield's 4-6-6-4's replaced 2-8-8-2 Mallets on coal and merchandise trains through the Appalachians on its line from Elkhorn City, Ky., through its shop town and headquarters of Erwin, Tenn., to Spartanburg, S.C.

Baldwin built 10 Challengers in 1937 of an entirely new design for the Denver & Rio Grande Western. These were big engines, used in manifest freight service across mostly desert terrain between Helper, Utah, and Minturn, Colo. In 1942 Rio Grande received five more, and their service territory was extended west to Salt Lake City. Rio Grande wanted yet more Baldwins during the war, but owing to War Production Board restrictions, D&RGW was forced to lease six built by Alco, diverted from a UP order. After the war, the six UP-design engines were returned to the government and later sold to the Clinchfield.



READY TO HELP: Delaware & Hudson Challengers 1529 and 1525 wait on the Cascade Wye north of Lanesboro, Pa., to push the next freights needing help over Ararat Summit.

Baldwin also built a dozen 4-6-6-4's in 1940 for Western Maryland, which ran them on its main line through the mountains between Connellsville, Pa., and Hagerstown, Md. They were smaller than the D&RGW Challengers.

THE BIGGEST: BIG BOY AND ALLEGHENY

The year 1941 saw further development of the fast-freight articulated, with two new types introduced. Once again UP was involved, as was Chesapeake & Ohio. UP's proving ground for new power was traditionally the grade through the Wasatch Mountains from Ogden, Utah, to Evanston, Wyo. The line has grades of 1 percent, but curvature is such that the track speed is 35 mph or better in many places. UP traditionally looked for locomotives that could handle trains here without doubleheading. In 1940, this was Challen-

GEORGE SPEIR

EPITOME: Union Pacific 4-8-8-4 4012 leaves Laramie, Wyo., eastbound in September 1957. The smoke visible behind the train is from the 4006, ready to follow.

ger country, but as trains became heavier, the 4-6-6-4's were being taxed to their limit and UP again collaborated with its favorite supplier, Alco, to work on a solution.

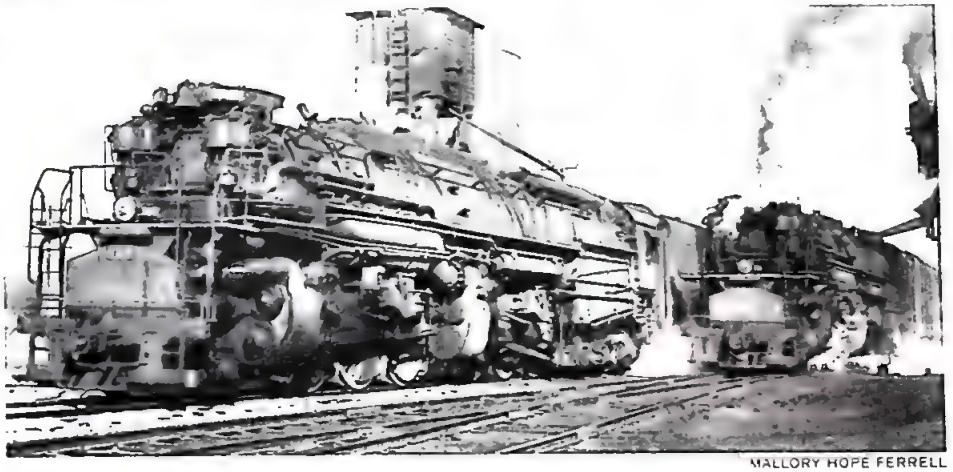
The new design had to have the same speed capability as a Challenger, plus greater adhesion. UP wanted a locomotive that could pull like a 2-8-8-4, but run like a 4-6-6-4. The result was the 4-8-8-4, which became known as "Big Boy" and, like the 4-12-2, was built only for the UP. With the introduction of the 4-8-8-4, the practical limit in size for the reciprocating locomotive had been reached—one simply could not build anything larger. The Big Boys had long boilers with huge, but shallow, fireboxes supported by the last two driving axles and the trailer truck. They rode on 68-inch drivers that were a bit smaller that those of a Challenger to better provide clearance for the mammoth boilers.

The first 20 Big Boys were delivered in 1941. In preparation for their entering service, UP had to the adjust the clearance on many curves and turnouts on its double-track main line to accommodate the substantial overhang of the boilers. The Big Boys performed magnificently and were capable of producing over 6000 horsepower at the drawbar. During the war, UP took 5 more, and their operating territory was extended east to Cheyenne, Wyo. The 4-8-8-4's represented the high-water mark for UP steam. In their later days, they called Sherman Hill (west of Cheyenne) home, and they ran until the end of UP steam in 1959. Eight are preserved across the U.S.

C&O needed to replace its obsolete single-expansion 2-8-8-2's on its route through the Allegheny Mountains, so its Advisory Mechanical Committee (AMC) set about designing a new heavy fast-freight engine. In common with neighbor and rival N&W, C&O's AMC began the process by designing an extremely powerful boiler. They elected to employ a large and deep firebox set behind the rear drivers, so big that it needed a three-axle trailer truck for support. By this decision the AMC also had elected to build a six-coupled articulated, since with the firebox set behind the drivers, it was not possible to accommodate two sets of eight-coupled wheels as on the Big Boy. So the type became a 2-6-6-6.

The boiler's girth gave it a tremendous amount of free gas area, an important factor in heat transfer. It als o had an incredible amount of evaporative heating and superheating surfaces. Simply stated, it was the most power-

PHILIP R. HASTINGS



MALLORY HOPE FERRELL

OVERKILL? Some argue that the 2-6-6-6's of C&O and Virginian were miscast. No matter—they were handsome and powerful. C&O 1647 rolls 90 cars of coal by the Handley (W.Va.) office, while VGN 906 and 907 stand at Sewalls Point in Norfolk, Va.

ful boiler ever placed on a reciprocating steam locomotive. Driving-wheel diameter was held to 67 inches in order to keep the locomotive within C&O's loading gauge. Lima Locomotive Works had collaborated with the AMC on the design, and the Ohio builder got the order for the first 10 locomotives. C&O called its new breed the Allegheny type when the first ones went into service on the Allegheny Division between Hinton, W.Va., and Clifton Forge, Va. Deliveries by Lima of 10 more in 1942, 25 in 1944, and a final 15 in 1948 extended their operating territory across the entire C&O main line between Newport News, Va., and Toledo, Ohio.

During their trials the Alleghenys were recorded as producing more than 7000 drawbar horsepower, which made them the most powerful reciprocating steam locomotives built. Unfortunately, these magnificent beasts only occasionally had the opportunity to demonstrate this capability. Although they were designed for fast-freight service, they spent most of their short lives handling heavy trains on mountain grades or at the head of coal drags through Ohio. One can only ask if C&O would have been better served by a fleet of 2-8-8-4's, which would have had greater adhesion than an Allegheny and could have handled bigger trains over the same territory.

In 1945 the third Pocahontas coal road, the Virginian Railway, also received eight Alleghenys from Lima. Virginian used them to replace 2-8-8-2 and 2-10-10-2 Mallets on coal drags between Roanoke and Norfolk. As with C&O, this was not exactly the service for which the locomotives were best suited. Given that diesels were superior power for heavy trains and mountain grades, the Allegheny was an easy and early target for replacement. Virginian's 2-6-6-6's were out of service by 1954, and C&O's by 1956. Two C&O Alleghenys are preserved.

In any discussion of fast-freight articulated locomotives, one cannot help questioning the motive-power decisions made by some of the eastern carriers. Besides C&O and Virginian, the Delaware & Hudson, Western Maryland, and Clinchfield quickly come to mind. These three roads ran 4-6-6-4's through mountainous terrain and in slow-speed services not appropriate for the design. Among the three, only WM seemed to acknowledge this when it found that its modernized 2-10-0's were pretty much able to handle the same assignments as its Challengers.

Further, might not the Clinchfield have been better served by Yellowstones at the head of its coal drags running over its sinuous Appalachian route? The same issue can be raised with the D&H. Wouldn't a 2-8-8-4 have been a better choice on its coal trains, or as helpers up Ararat? With the exceptions of Seaboard's and Norfolk & Western's 2-6-6-4's, the fast-freight articulated was most at home in the West. In that natural habitat, it successfully sped heavy manifest freights across the high plains and lonesome deserts traversed by America's western transcontinental railroads.

Going out in **GLORY**

Zipping down the Peninsula

Firing a 4-8-2 on SP's hot overnight freight out of San Francisco

BY **BARRY ANDERSON**

LATE ONE AFTERNOON in August 1953 I picked up the phone to hear the crew dispatcher say, "Anderson, you're called for the Zipper. Five fifty-five on duty Mission Bay. Engineer Neville. Engine 4311." I'm sure my heart skipped a couple of beats, for that phone call meant I was going to get to fire the hottest freight train on the system.

For this young railfan-locomotive fireman, there was no better place to be than Southern Pacific's Coast Division in the waning days of steam. By 1953, diesels were rapidly replacing steam locomotives all over the system, with the more serviceable of the survivors working out their days on the Coast and Western divisions.

The "Zippers" were actually the Coast Merchandise West and East, trains 373 and 374, between Los Angeles and San Francisco. Distinctive black boxcars displaying a golden arrow with the word "Overnight" carried time-sensitive, less-than-carload shipments 469 miles between the close of business one day to the opening of business the next. Typical power was one of SP's 4-8-2's or *Daylight* 4-8-4's that could move the train over the division at passenger-train speeds.

At Mission Bay roundhouse this evening, our 4311, a speedy and powerful 4-8-2, stood on the ready track beside 4-8-4 4459, assigned to train 94, the *Starlight*. This reminded me that tonight we'd be in the middle of a "sandwich" of passenger and freight trains departing San Francisco and running down the Peninsula on headways of just a few minutes. There'd be no relaxing on this run tonight.

SP 4-8-2 4346 on a fast boxcar train not unlike fireman Anderson's Zipper rolls south below San Francisco in April 1951.

REGINALD MCGOVERN

We backed down to our train at the freight sheds at 4th and Berry streets—just 27 cars tonight, but we'd pick up more at San Jose. Several tracks over, at the passenger station, we could see the 4459 coupling onto the waiting *Starlight*. She was due to leave just 10 minutes behind us and would be tasting our smoke all the way to San Jose. We were like two racehorses at the starting gate.

Engineer Neville shouted across the cab, "You ready? OK, let's go get 'em!" Easing out onto the main line, we quickly picked up speed through the four tunnels. By the time we passed Bayshore (the main San Francisco freight yard), the 4311 was whipping along at 60 per. Six miles behind us, the *Starlight* was pulling out of the station in our wake. On the double track 10 miles ahead, No. 152, a local passenger train, was just leaving Burlingame.

Though not as well known as the streamlined *Daylight* 4-8-4's, these 4300's were classy engines. The 4311 was nearly 30 years old and just 3 years away from retirement, but you'd never know it the way she performed. She was as smooth and tight as the day she was built and rode so well you could have balanced a glass of water on the backhead. Tall, 73-inch drivers enabled her to run like a deer. Skyline casing and semi-streamlining gave her a greyhound look.

Across the cab, Neville had a big smile on his face; I could see he enjoyed running this machine as much as I enjoyed firing it. He'd babied the reverse lever up into the "company notch" that made the exhaust just a staccato chatter. The water in my sight glass was rock steady; the steam was right on the peg at 210; there was a white-hot glow at the firebox door; the stack showed just a gray haze of smoke. This is what railroading was all about.

We rocketed through Burlingame, past passengers on the platform waiting for the *Starlight*, which by now was just 8 minutes behind us. He had stops here and at Palo Alto, so we'd widen the gap a bit, but he'd close it again before we got to San Jose. If he saw a yellow signal from us, we'd certainly hear about it. Up ahead, 152 led us by just 5 minutes.

My engineer shouted across the cab, "You ready? OK, let's go get 'em!"

San Mateo, Belmont, San Carlos, and Redwood City flashed by in a blur. A TBX (trans-Bay extra) from Oakland slammed by on the westward track. At Redwood Junction, a big cab-forward waited in the clear with a long Bayshore-bound drag from Tracy.

The signal at San Jose yard showed red-over-yellow. Neville pinched her down to a brisk walk as we clattered through the crossover onto No. 1 track. Only moments later, it seemed, 94 sped past on the main for his stop at San Jose.

We spent 40 minutes at San Jose while a switcher tied on another 15 cars that had just come down from Oakland on connecting train 336. Neville dropped to the ground to oil around, and I climbed atop the big 16,000-gallon tender to take on the water we'd need for the run to Watsonville Junction. We just had time for a quick cup of coffee and slice of pie in the yard beanery, which was famous among railroaders for its homemade pies.

The Zipper's schedule called for a time of 1 hour, 5 minutes over the next 50 miles to Watsonville Junction. With 94 now ahead of us and 76, the *Lark*, following us by 55 minutes, the tension in the cab eased a bit. Still, the Gilroy Subdivision, with one long grade and two stretches of single track, was not a racetrack.

The herder swung his green lantern in a highball, and promptly at 8:20 we were off again. Heeling around the curve at Coyote, I could see the green train-order signal and called, "clear board." We were a first-class train and not likely to have any orders restricting us; anything coming against us should be clear in a siding long before we arrived.

Neville slowed her to the required 15 mph as we negotiated the spring switch onto single track; then, when the caboose was clear, he dropped the reverse lever down several notches and widened on the throttle. The stack noise quickly changed to a deep-throated bark as the 4311 dug in. The ruling grade for the next few miles was only about 0.6 percent, but it was enough to make the big 4-8-2 earn her keep maintaining the schedule with our 42 cars.

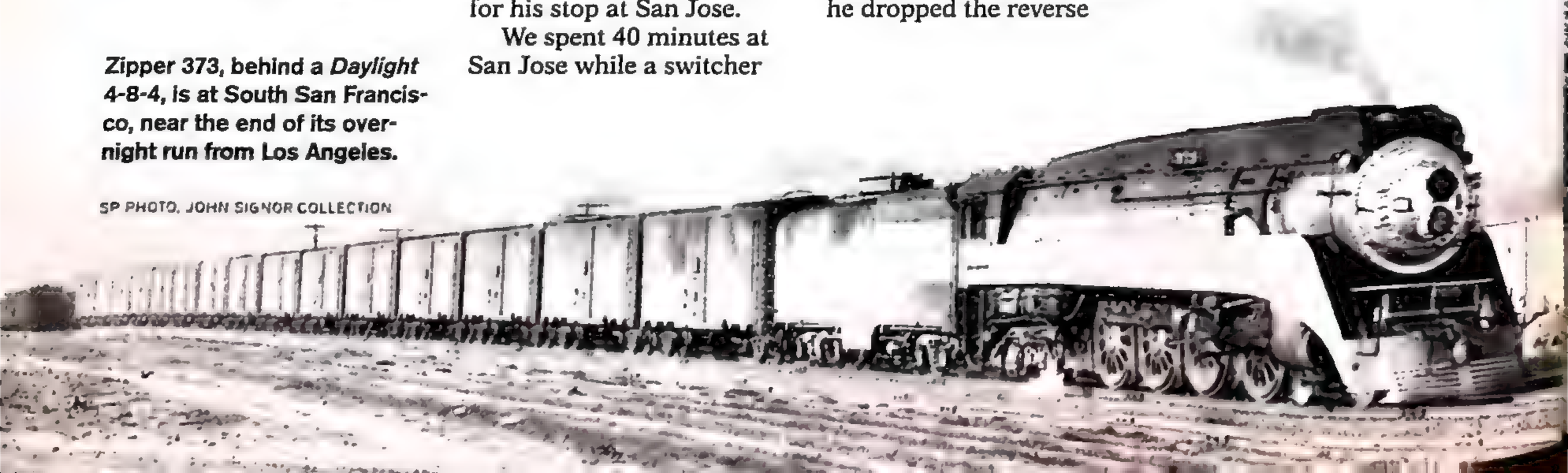
All the way to Gilroy we paralleled U.S. Highway 101, and as we pushed our permitted 70 mph, I could see some motorists trying to keep up with us, their kids wildly waving from the back seat. The head brakeman and I waved back. At Morgan Hill, a cab-forward with First 937 and a long string of reefers was waiting in the hole for us. It was mid-summer, and the lettuce rush was in full swing, with solid reefer blocks departing Watsonville Junction westbound every couple of hours.

Beyond Gilroy, the single track snaked through Chittenden Canyon, then split into double track for the last 6 miles to Watsonville Junction. As we eased to a stop at the water plug, I saw Neville pull out his watch. I looked at mine—9:20 sharp, right on the advertised!

I was lucky enough to catch the Zipper several more times off the extra board in the ensuing years, but this was my last time to fire steam on this run. By the following summer, GP9's had taken over the Zipper, and the thrill was never the same again. ■

Zipper 373, behind a *Daylight* 4-8-4, is at South San Francisco, near the end of its overnight run from Los Angeles.

SP PHOTO, JOHN SIGNOR COLLECTION



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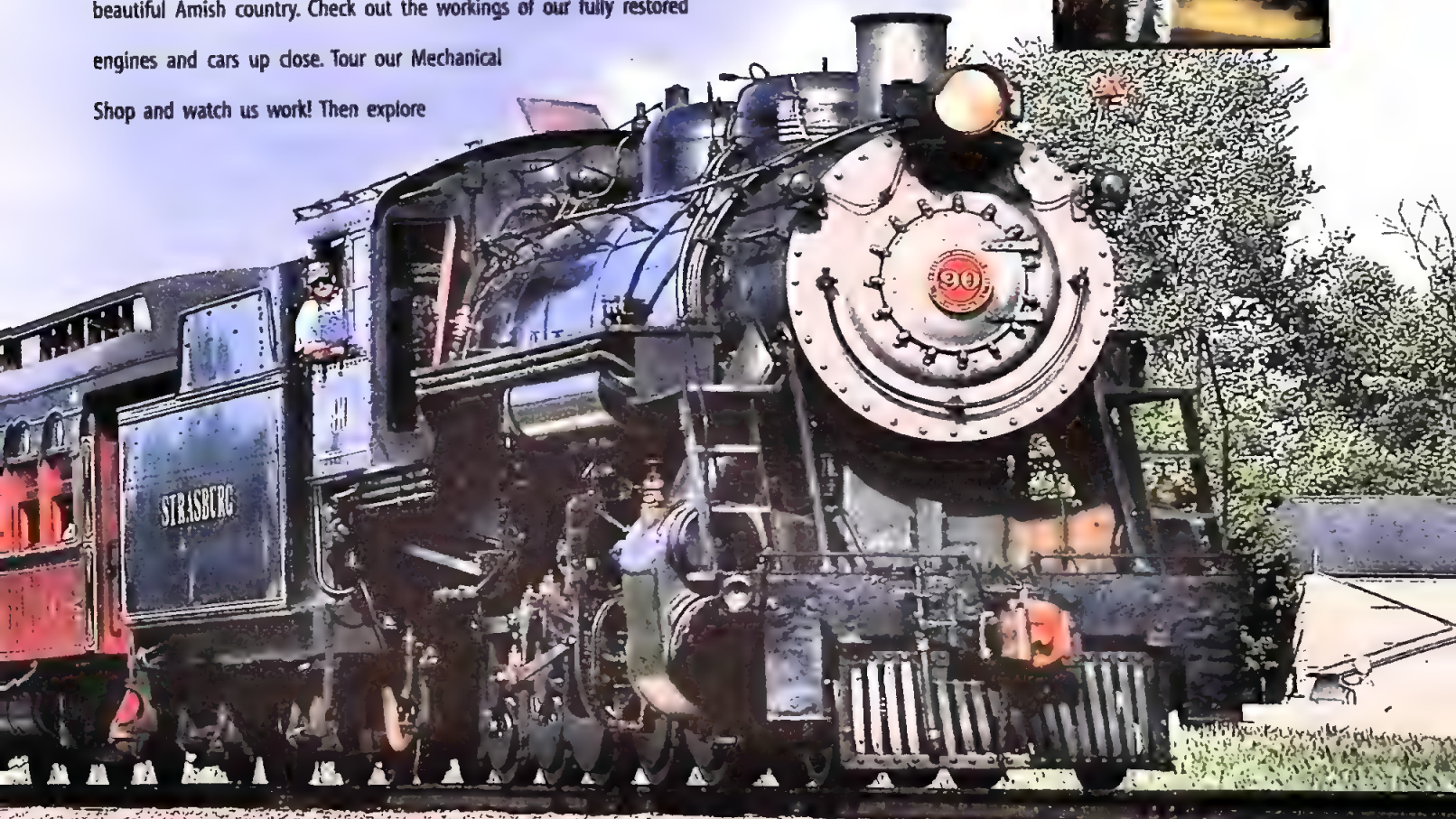

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BOWEN'S BEAUTIES

Colorful semi-streamlining adorned 86 Canadian Pacific locomotives of three types

BY **KEVIN J. HOLLAND**

DURING THE MID-1930's, North American railroads rushed to embrace streamlining as a panacea for their Depression-induced decrease in passenger traffic. The art, and science, of streamlining emerged at a tumultuous time in the evolution of motive power, with internal combustion options like Burlington's *Zephyr* gaining credibility even as steam-locomotive design reached what would be its zenith. For a few years, at least, streamlining—as a means of "packaging" locomotives to meet the fresh expectations of both the public and railroad management—was applied with equal zeal to steam, diesel, and electric locomotives.

Designers of streamlined steam locomotives tended to embrace one of two methods. Full shrouding, as pioneered by New York Central's *Commodore Vanderbilt*, concealed beneath a sheet-metal cloak virtually all the locomotive's characteristic components, often including much of its running gear and tender. Front-end treatment tended toward either a *Zephyr*-like shovel nose or variations on hemispherical smokebox fairings. Contrasting what were often derided as "inverted bathtubs," advocates of "semi-streamlined" design smoothed, but did not completely mask, the steam locomotive's integral assemblies with the likes of boiler jackets, skyline casings, running-board skirts, and pilot and smokebox styling efforts.

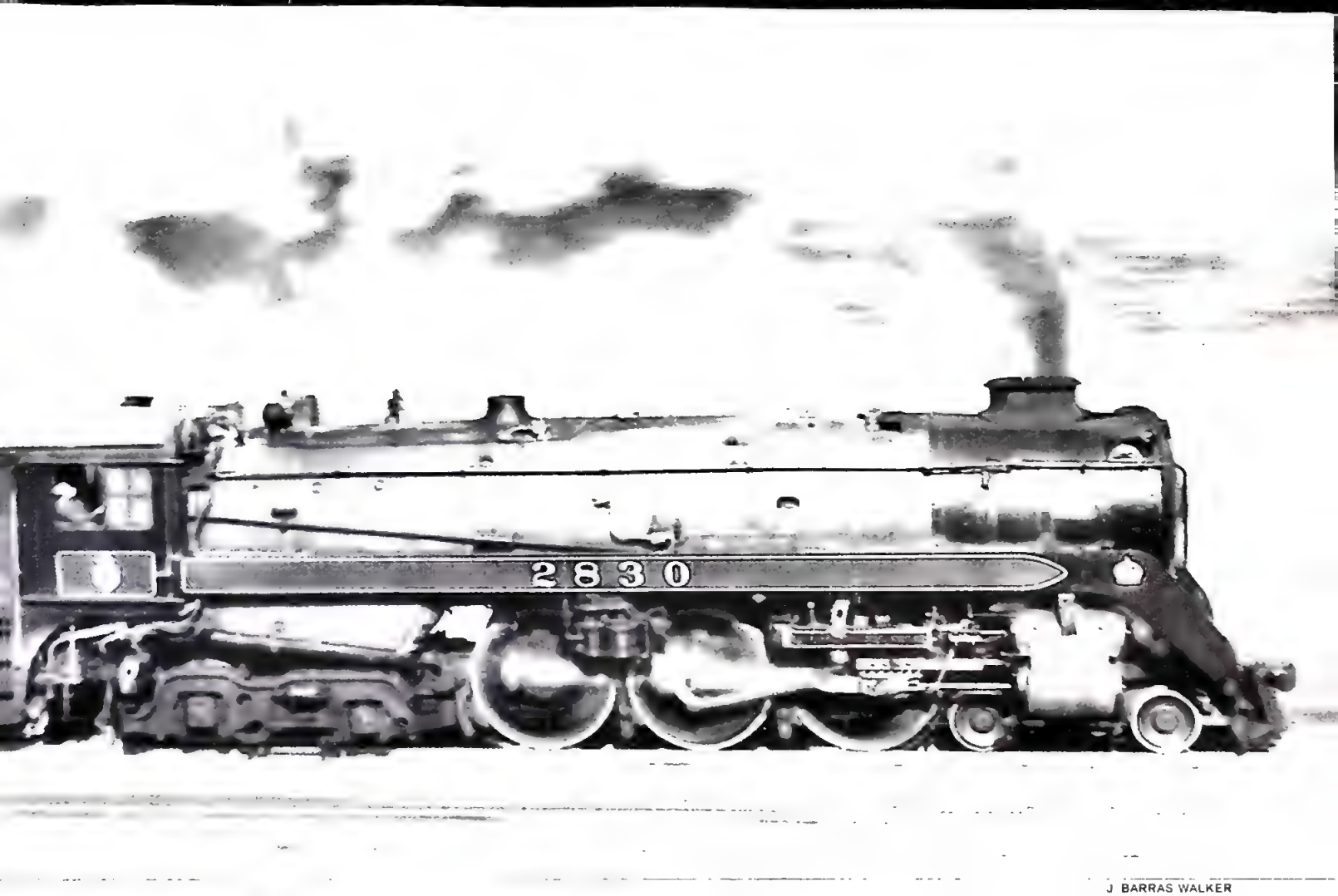
THIS ARTICLE IS ADAPTED FROM THE AUTHOR'S BOOK, *THE STEAMLINERS* (TLC PUBLISHING, 2002).

Among the most successful practitioners of semi-streamlined steam-locomotive design was Canadian Pacific Railway's Henry Blane Bowen.

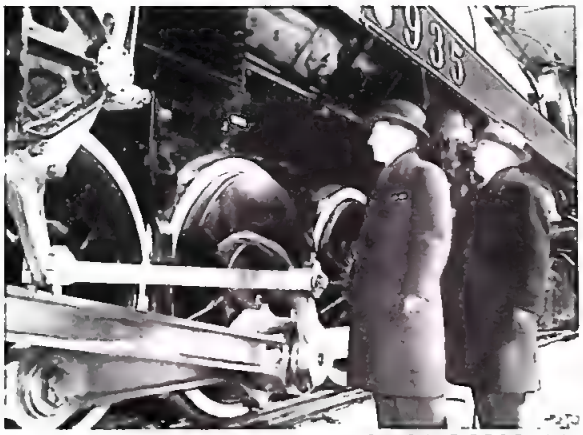
Bowen had 23 years of CPR service when he was appointed its Chief of Motive Power and Rolling Stock in September 1928. English by birth, Bowen from the mid-1930's through his 1949 retirement created a body of work that flavored CPR's passenger trains with British undertones and a dash of Midwestern American influence.

Born in Derbyshire May 17, 1884, Bowen was educated at the Manchester School of Technology and L'Ecole de Commerce in Lausanne, Switzerland, followed by a special apprenticeship at the Manchester engineering firm of Crossley Bros. from 1901 to 1904. By the next year, Bowen had emigrated to Canada and secured employment with Canadian Pacific. After a short stint as a machinist's apprentice at Angus Shops in Montreal, Bowen transferred to the Winnipeg shops as a draftsman. Rising through the engineering ranks, he became Chief Draftsman (Mechanical Department) in May 1911, Chief Engineer in September 1918, and Works Manager of the Weston shops complex in January 1920. After a two-month assignment as Superintendent of Motive Power (Western Lines), still in Winnipeg, Bowen moved back to Montreal in September 1928 as CPR's new Chief of Motive Power and Rolling Stock.

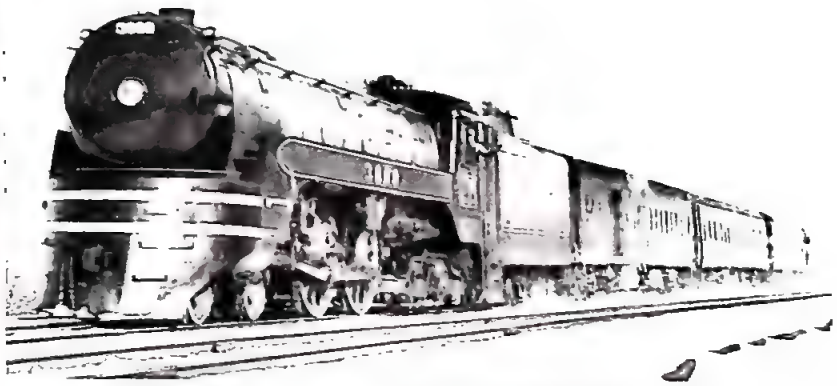
Upon his return to Montreal, Bowen evaluated



J. BARRAS WALKER



CANADIAN PACIFIC RAILWAY



PATTERSON-GEORGE COLLECTION, COURTESY DAVE SHAW

Henry Bowen (at right in photo at left), stands with CPR President N. R. Crump by Selkirk 5935; Royal Hudson 2830 is in full flight (top) near Medicine Hat, Alta.; and Jubilee 3000 rolls train 629 at Cooksville, Ontario, in 1949.

CPR's motive-power needs with a fresh eye, diplomatically eschewing the two recently built "experimental" class K1 4-8-4's developed by his predecessor, C. H. Temple, as too heavy for general service. In their stead, but nonetheless influenced by elements of Temple's work, Bowen promptly initiated designs for several specialized locomotive types new to CPR, including two destined to cast long shadows: the H1a class 4-6-4 and the T1a 2-10-4. Bowen also saw merit in the lightweight, streamlined passenger-train designs emerging in the U.S. in the early '30's, and lent his own distinctive flair to the steam-powered vest-pocket streamliners introduced by CPR in 1936.

Canadian Pacific's roster was enlarged by 462 new steam locomotives during Bowen's tenure as motive power chief. Remarkably, nearly 200 of them were built in the five years leading up to his retirement, at a time when most of his counterparts in the U.S. were embracing dieselization. Reflecting his tenacity in upholding the merits of reciprocating power, Bowen also introduced Canada's last new steam-locomotive design, the G5 class Pacific of 1944. A steam stalwart to the end, Henry Bowen died in Montreal on January 20, 1965.

JUBILEES

CANADIAN PACIFIC RAILWAY

At Montreal, pristine 3003 is poised for her 178-mile run to Quebec City as the engineer gets his orders. Sister 3001 arrives in Calgary from Edmonton with 528, the *Stampeder*, July 18, 1950.

A. H. COVERDALE

IN 1936, CPR UNVEILED four streamlined, lightweight four-car trains plus five streamlined class F2a 4-4-4's to pull them. Fifty years had passed since the first Canadian Pacific transcontinental passenger train departed Montreal for the Pacific coast, and the five F2a's were named Jubilees in honor of the anniversary.

Evoking the lines of the London, Midland & Scottish *Royal Scot* consist which had toured Canada and the U.S. in 1933, the smooth, welded sides of Bowen's new lightweight cars curved slightly inward at the top and bottom, with sides and roof merging almost seamlessly. The sides were painted in CPR's traditional maroon, with the roof and underbody black. Square-cornered, vertically oriented windows mimicked Milwaukee's 1935 *Hiawatha*, and the broader parallel was more than coincidental. Karl Nystrom—responsible for much of the *Hiawathas'* engineering and design as superintendent of Milwaukee's car department—had worked as a colleague of Bowen's as CPR Car Department's Chief Draftsman, based in Montreal, during 1918-20. The new CPR trains departed from Milwaukee's year-old precedent in the manner of their engines' smokebox streamlining and the number and configuration of cars, but the similarities were nonetheless striking.

Each four-car train included a mail-express car, a baggage-buffet-coach, and two full coaches. Initially, Jubilees 3003 and 3004 and two consists were assigned to the 178-mile Montreal-Quebec City trains 349-352, while 3000 and 3002 and a third consist covered *Royal Yorks* 37-38 on the 229-mile Toronto-Detroit run. The fourth lightweight train

J. F. BEVERIDGE PHOTO, RAILWAY MEMORIES COLLECTION

Shiny Jubilee 3000 heads the short consist of Toronto-Detroit train 629, making its West Toronto stop at 4:15 p.m., April 9, 1954.

became the *Chinook*, a 194-mile Calgary-Edmonton run pulled by Jubilee 3001, which for a time wore cast plates with the train name. This Jubilee stayed out in Alberta, working Medicine Hat-Lethbridge locals and then the *Eskimo* and *Stampeder* before being scrapped in 1957.

As for the 4-4-4's themselves, built by Alco affiliate Montreal Locomotive Works, their wraparound pilot design, cylinder skirting, and boiler jacket all emulated the Milwaukee Road class A Atlantics of 1935. Bowen gave his Jubilees a broad, smooth smokebox front, barely convex in profile. A flush-mounted headlight was centered on the nose, and, as built, a grilled air intake occupied the upper fifth of the circle. The only protrusion atop the boiler jacket was a stack fairing, teardrop-shaped in plan with an integral illuminated numberboard on either side. A pair of teardrop marker light housings was mounted at the point where the chrome handrails curved onto and down over the nose in a deep "U" shape.

Vestibule-type cabs had become common in Canada, owing to the difficult winters, and Bowen integrated 2-foot-deep running-board skirts into the Jubilees' cab sides. No attempt was made to streamline the forward half of the tender, with its angular coal bunker, but the aft portion matched the height and approximate cross-section of the new lightweight cars. Tenders rode on four-wheel trucks and could carry 12 tons of coal and 7000 (Imperial) gallons of water.

The F2a's placed 121,000 pounds (of a total engine weight of 263,000) on their 80-inch drivers, and operated with a boiler pressure of 300 PSI. The five were the only CPR steam locomotives equipped with Boxpok drivers. Cylinders measured 17½x28 inches. Tractive force was a modest 26,600 pounds, deemed ample for the short, fast trains the 4-4-4's were designed to pull.

Speedsters they were, as 3003 established the highest officially recorded speed for a steam locomotive in Canada, hitting 112.5 mph outside St. Telesphore, Que., on a September 18, 1936, brake test on CPR's Winchester Subdivision.

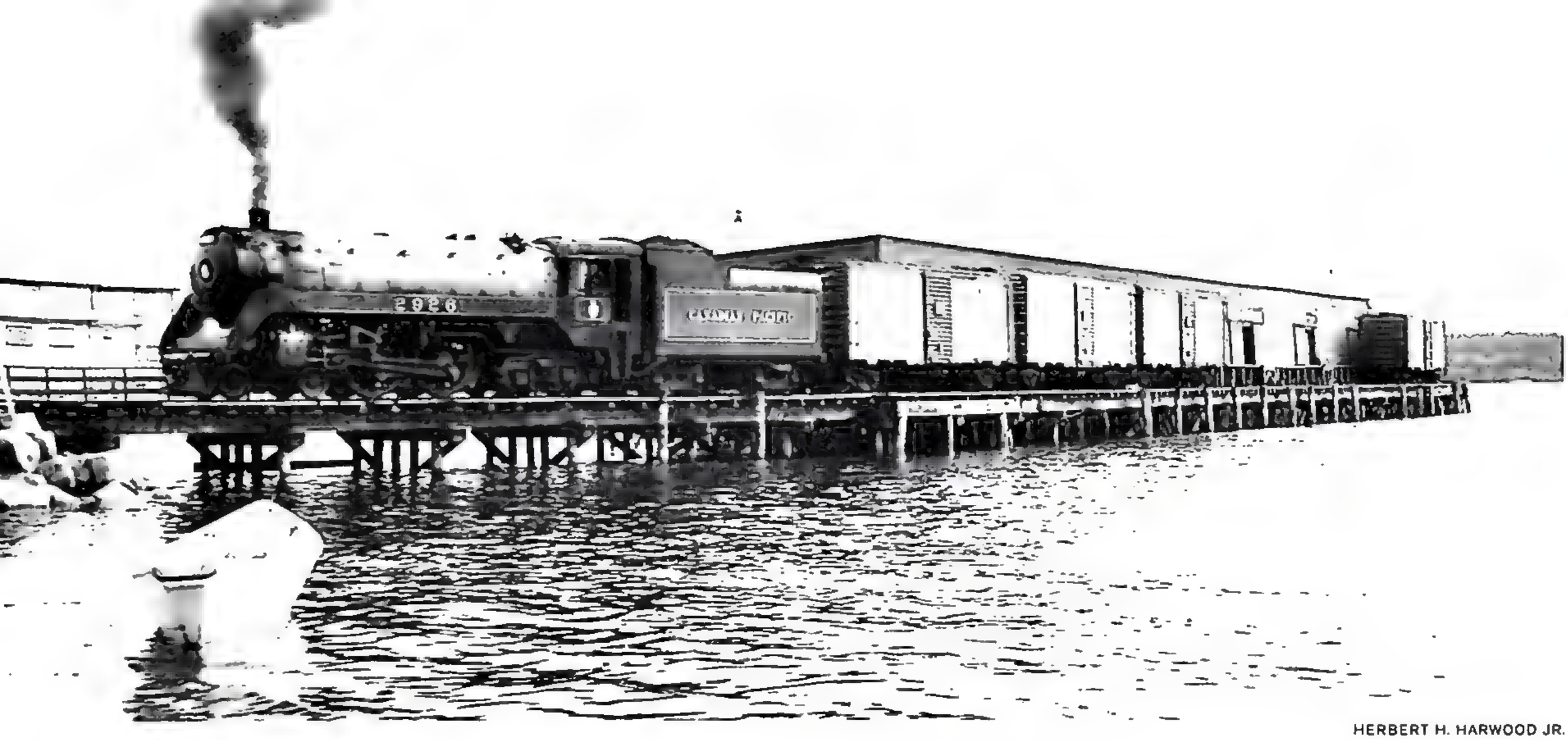
Gloss black paint was relieved by planished steel on the boiler jacket aft of the smokebox, and gold-edged maroon panels on the running-board skirts, cab ides, and tender. A pair of stainless-steel bands wrapped around the smooth pilot, behind which was concealed a retractable coupler. Lettering was gold, and a multi-colored CPR crest adorned each side of the cab. After 1949, CPR replaced the gold leaf employed for steam-locomotive striping and lettering with an economical but hard-wearing yellow paint.

After a few years, the retractable couplers were dispensed with—they had proved unreliable in the wake of grade crossing collisions. By the late 1940's, the grille in the upper nose had been blanked and replaced with a single large illuminated number board in lieu of the originals flanking the stack. The bell migrated from its original position beneath the left-side front cowling, where it was somewhat muffled and prone to snow and ice clogging, to the top of the boiler.

Next in Canadian Pacific's streamlined stable were 20 lightweight 2900-series class F1a 4-4-4's built by Canadian Locomotive Company (CLC) in 1937-38. Designed for branch-line and local service, Nos. 2910-2929 were counterparts to the F2a's, but more diminutive with 75-inch drivers (vs. 80) and a shorter wheelbase, 26,000 pounds tractive force, and 240,000 pounds engine weight. Boiler pressure, however, was the same—300 PSI. The F1a's lacked the power reverse and stokers of the earlier F2a's.

(Why did class F1a come *after* class F2a? Prior to 1917, CPR had three 4-4-2's assigned to class F1. The 3000-series Jubilees of 1936 were the next four-coupled engines, hence F2. The differences were significant enough to preclude the 2900's becoming F2b's. Logically, they should've been classed F3, but F1a's they became.)

The F1a's were primarily passenger engines but did see



HERBERT H. HARWOOD JR.

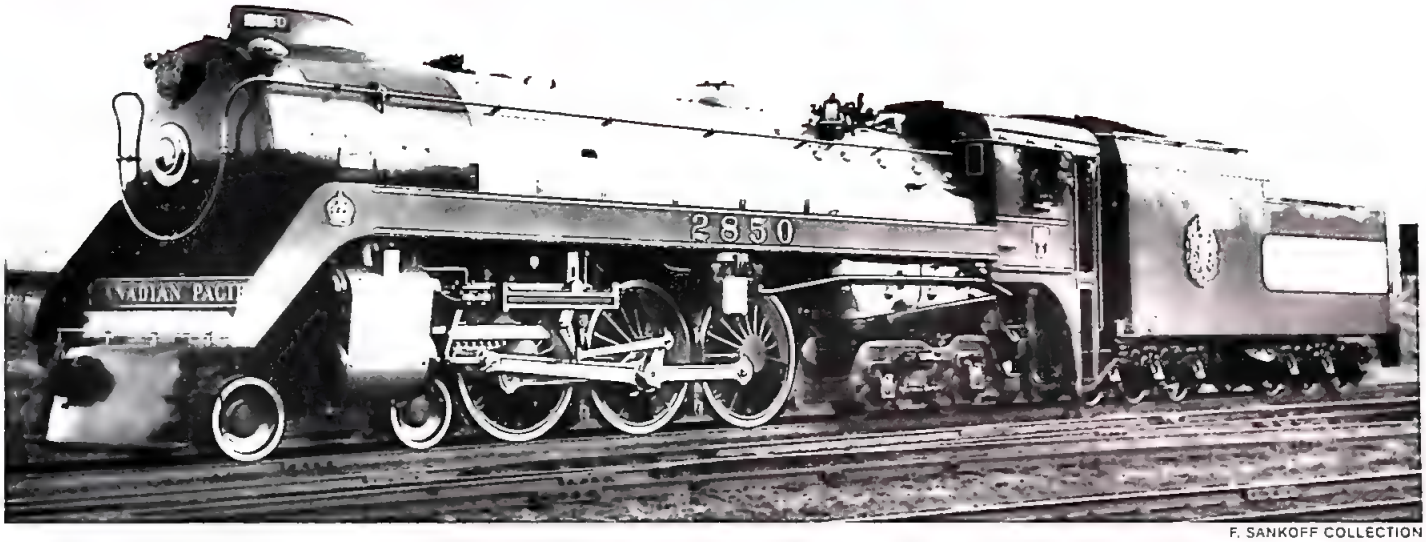
J. F. BEVERIDGE PHOTO, RAILWAY MEMORIES COLLECTION

Jubilee 2926, on the McAdam wayfreight, switches the fish-processing dock at St. Andrews, New Brunswick, in August 1959; sister 2928 was on train 637 at Guelph Junction, Ont., in May '54.

occasional freight service. Their original assignments had 15 at Moose Jaw, Sask., and Winnipeg, with the other 5 divided among Toronto, Ottawa, and McAdam, New Brunswick.

With these, and subsequent CPR semi-streamlined engines, Bowen abandoned the wraparound pilot and clean-topped boiler jacket. A smooth prow pilot was surmounted by a sloping, flat sheet leading up to the underside of the smokebox, and the running-board skirting continued forward and down at an angle to meet the pilot beam. These changes improved access to the cylinders and other front-end equipment, a main reason Bowen had chosen what he termed a "semi-streamlined" form in the first place. He had observed in 1935, as design of the F2a Jubilees and their lightweight trains was under way, that "extreme designs" of streamlined shrouding (such as that applied to NYC's *Commodore Vanderbilt*) "will not meet safety appliance requirements and [will] make parts very inaccessible." Bowen said that he sought with the F2a Jubilees "to produce a locomotive having most of the modern developments to date, permitting as far as possible an increased ratio of power to weight and fuel consumption, and at the same time not to complicate matters from a construction or maintenance point of view, and also to keep the characteristic appearance of the locomotive as it has been known for years."

ROYAL HUDSONS



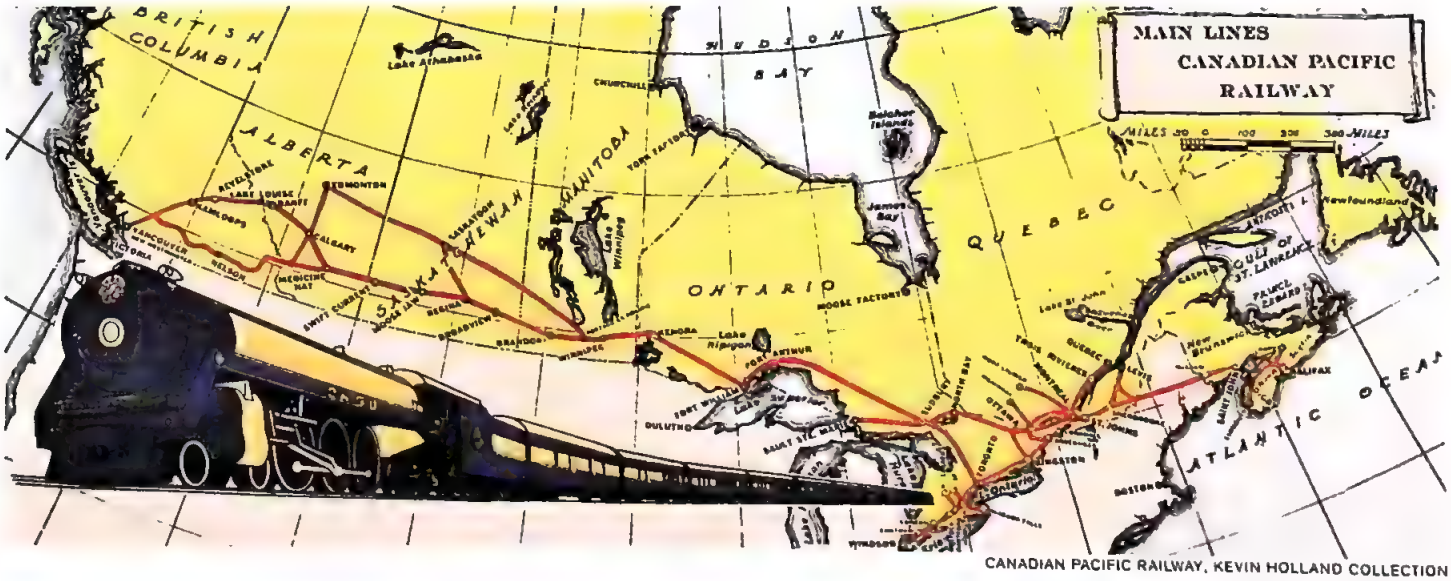
F. SANKOFF COLLECTION

Hudson 2850 was painted blue and silver, given stainless-steel jacket, handrails, and numerals, and adorned with crown and crest for the 1939 Royal Train of King George VI and Queen Elizabeth, who rode 3000 miles westward on the Canadian Pacific.

THE BEST-KNOWN Canadian Pacific steam engines, to students of railroad history as well as the general public, were the last 45 of the 65 2800-series 4-6-4's. All built by Montreal, the semi-streamlined engines comprised three subclasses, arriving in three groups from fall 1937 to mid-1940.

Bowen had seen in the Hudson a more versatile, and cost-effective, wheel arrangement than Temple's K1 4-8-4. While competitor Canadian National relied on eight-coupled power to spread engine weight over the often marginal trackwork and bridges CN had inherited from its cash-strapped predecessors, CPR's comparatively better infrastructure favored the 4-6-4 in all but the extremes of branchline or mountain service. In these areas, Pacifics and 2-10-4's, respectively, gave Bowen the capacity he sought.

CPR 2820-2849, class H1c, came in 1937; 2850-2859, H1d, in mid-1938; and 2860-2864, H1e, in June 1940 for western service. The H1e's were oil-burners, in deference to the heightened risk of forest fires in the mountains. Streamlining on these 45 Hudsons mirrored that applied to the F1a Jubilees, cementing Bowen's strong "family" appearance. Their clean, cylindrical boiler jackets were blemished only by a turbogenerator and safety-valve turret (and later, the bell) ahead of the cab, and barely perceptible blisters beside the forward portion of the stack fairing covering the ends of the Elesco feedwater heater. Beneath the planished jacket was the same tapered boiler found on non-streamlined Hudsons 2800-2819, along with a low-profile, saddle-style sandbox.



CANADIAN PACIFIC RAILWAY, KEVIN HOLLAND COLLECTION

J. W. SWANBERG

Late in the CPR steam era, 2839 doubleheaded behind G5 Pacific 1271 on a fan trip at Guelph Junction, Ont., on August 30, 1958; engine 2839 is one of four Royal Hudsons preserved. At Oakville, Ont., a year before, sister 2838 had a roll on train 712, bound from Buffalo for Toronto, off the TH&B at Hamilton.

J. F. BEVERIDGE PHOTO, RAILWAY MEMORIES COLLECTION

As he had done on the Jubilees, Bowen went for a slotted dry pipe in place of the traditional steam dome. In keeping with the Jubilees, these Hudsons' vestibule cabs were given radiused front corners.

The H1e's, assigned to mainline passenger work between Vancouver and Revelstoke, B.C., were delivered with a smaller stack fairing and an enlarged and relocated numberboard arrangement that would be retrofitted to the H1c's and H1d's. A single illuminated number glass was placed in the upper portion of the "full moon" smokebox front, greatly improving identification from the front.

The Hudsons rode on 75-inch drivers, had a boiler pressure of 275 PSI, employed 22x30-inch cylinders, weighed 194,000 pounds on drivers against a total engine weight of 354,000 pounds, and exerted 45,250 pounds of tractive force. Fifteen of them—H1c's 2838-2842, H1d's 2850-2854, and H1e's 2860-2864—were equipped with boosters, adding another 12,000 pounds tractive force. The booster-equipped engines—weighing 366,000 pounds total, with 194,000 on drivers—were selectively assigned to runs in northern Ontario and out west that had heavy grades. Tenders rode on two six-wheel trucks and held 12,000 Imperial gallons of water, plus either 21 tons of coal or 4100 Imperial gallons of fuel oil.

CPR's sleek Hudsons gained collective fame through the celebrity of the 2850, selected to pull the 1939 Royal Train of King George VI and Queen Elizabeth (parents of the current Queen Elizabeth II) over the Canadian Pacific portion of its route. So exemplary was the performance of 2850 and pilot train locomotive 2851 during more than 3000 miles of closely scrutinized duties that Bowen sought, and received, Royal permission to place cast metal crowns—like the ones that had graced 2850 during the tour—on the forward running-board skirts of all 45 streamlined 4-6-4's. As a result, they were known thereafter as Royal Hudsons.

The 2850 followed up its stint on the Royal Train with an appearance, along with its regal compatriot, Canadian National U-4-a 4-8-4 6400 (a 1936 Montreal product) at the 1939

CPR PHOTO, KEVIN J. HOLLAND COLLECTION

Its blue and silver contrasting with the green, gray, and white of the Rockies, the Royal Train steams west near Beavermouth, B.C.

New York World's Fair. The blue-and-stainless-steel Hudson made its way from Toronto to New York over CPR subsidiary Toronto, Hamilton & Buffalo and the NYC system: Michigan Central, New York Central, West Shore, and Boston & Albany to Chatham, N.Y., then the Harlem Division to the New Haven Railroad, across Hell Gate Bridge to the Long Island Rail Road, and on to the Flushing Meadow Fairgrounds.

Although the Royal Hudsons saw service across Canada, they were long assigned in clusters to various regions. Nos. 2820-2828 and 2858-2859 originally were based in Montreal, with 2829-2837 and 2843-2849 in Winnipeg (they ranged as far west as Calgary, Alta.). Booster-equipped 2838-2842 held down assignments on the *Dominion* and other heavy transcontinental schedules between Toronto and the north shore of Lake Superior, while 2850-2854 ran on the same trains between Fort William (now Thunder Day), Ont., and Winnipeg. Nos. 2855-2857 were based in Toronto, while 2860-2864 called Revelstoke and Vancouver, B.C., home.

Not surprisingly, Jubilee and Royal Hudson imagery figured prominently in Canadian Pacific advertising through the 1940's. Engine crews, however, did not always share the Advertising Department's fondness for Bowen's styling. The late Lawrence Stuckey, a CPR Prairie Division fireman and engineer intimately familiar with the Royal Hudsons, came to know first-hand the hazards of even modest streamlining on a steam engine. The cowling's main function, according to Stuckey, "was to provide a slippery plate cover over what had been handy foot- and handholds when [we] climbed about the machine doing small mechanical chores. Sometimes getting at the part [we] wanted to work on involved opening a metal door which could snap back on [a] hand like a mousetrap. One large door on the left side of the smokebox cowling, for access to the main auxiliary steam valve and blower connections, had a collapsible brace to hold it up and a clamp to hold it shut. The clamp usually worked all right, but when it didn't, the fireman could watch the door flap like a bird while he tried to watch the signals ahead."

His wry observations notwithstanding, Stuckey admired the Royal Hudsons' power and ease of operation, particularly after their widespread conversion to oil fuel (along with other classes of Prairie-assigned passenger power) after 1949. "With the nearly instant reaction of a fire to oil-burning controls," Stuckey recalled, "we could regulate steam and water with extreme accuracy. Whether the engine was exerting maximum power or standing still, needles stood on the steam gauges as if soldered there, and water levels steady as ice in the gauge glasses."

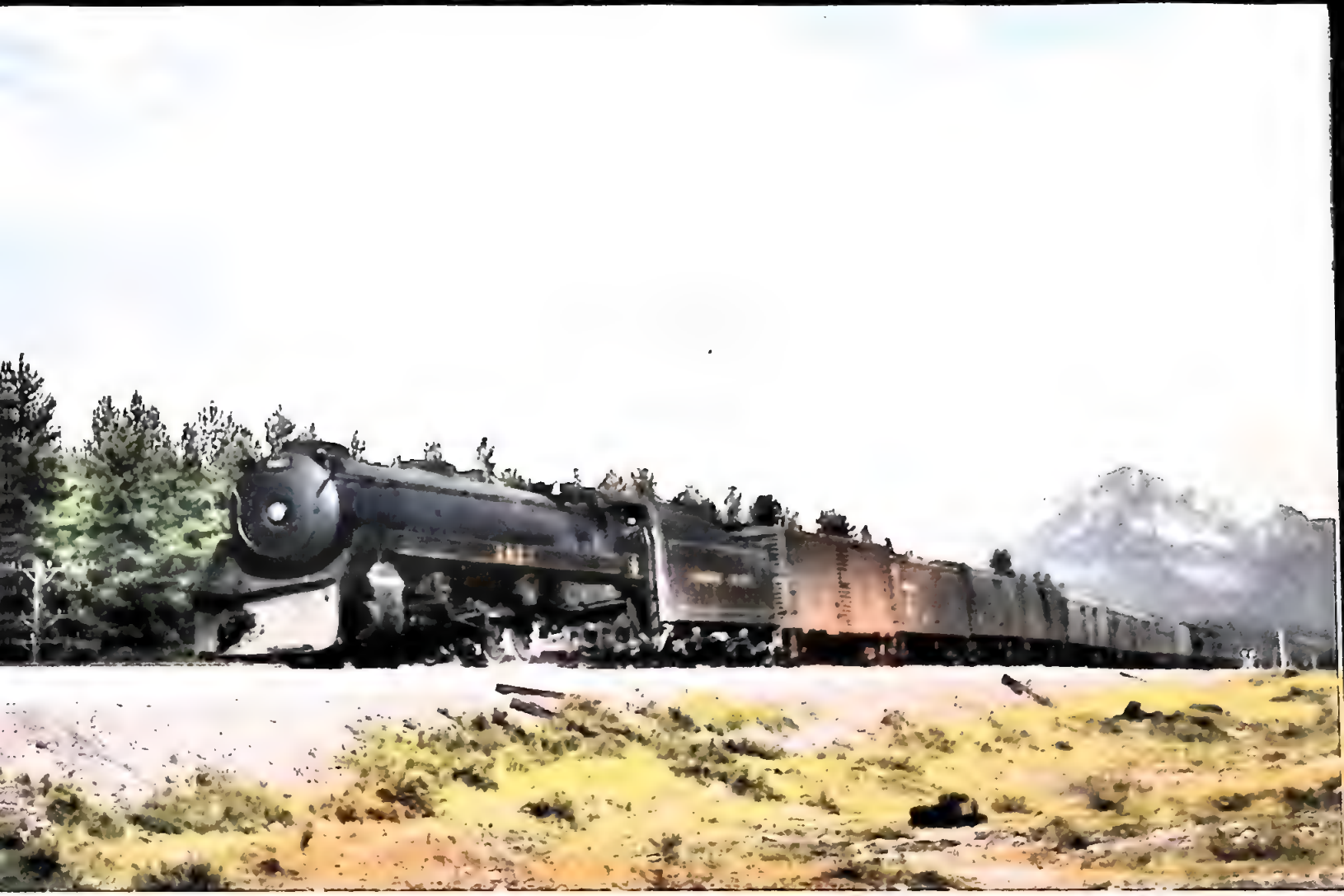
SELKIRKS

GEORGE C. COREY

MAURICE CHANDLER PHOTO, ROBERT TURNER COLLECTION

In British Columbia, the Royal Hudsons were augmented by semi-streamlined 2-10-4's given the class name Selkirk, a nod to the mountain range they would conquer in service, following a 1938 employee contest. The Selkirks, progressive editions of Bowen's 20 nonstreamlined T1a's of 1928, arrived from MLW in two groups: T1b's 5920-5929 in 1938 and T1c's 5930-5935 in 1949 (the 5935 would be CPR's last new steam locomotive). They were the largest steam locomotives in Canada. All had 63-inch drivers, 25x32-inch cylinders, 285 PSI boiler pressure, and 88,900 pounds of boosted tractive force. The T1b's total engine weight was 447,000 pounds; the T1c's were 1 ton heavier. Weight on drivers was 309,900 pounds.

The Selkirks pulled the *Dominion* and other transcontinental passenger trains between Calgary and Revelstoke, and also worked in mountain freight service. In the words of the builder, "the design is the CPR standard 2-10-4 type, modernized and streamlined to conform with its modern 4-4-4 and 4-6-4 types, thereby continuing the same pleasing, striking appearance for all its new power built for mainline service." The 1938 and '49 Selkirks were unique among 10-coupled power on two counts: they were streamlined, and built for passenger service.



MAURICE CHANDLER PHOTO; ROBERT TURNER COLLECTION

Selkirks seldom were recorded on color film, though CPR did use this portrait of 5935 (right) on a promotional brochure. At Field, B.C., on July 28, 1948, the 5923 heads out with a passenger train (above), and 5922 and 5929 are at the terminal (lower left). At Revelstoke (left), 5930 helps a 2-8-2 for 8 miles on a westbound freight, seen crossing the Columbia River in an undated photo.

The three CPR types' appearance notwithstanding, Bowen's 1949 retirement and the subsequent influx of General Motors FP7's and other boiler-equipped diesels after 1952 marked the beginning of the end for steam locomotives on CPR passenger trains. Bumped from the limelight, the Jubilees, Royal Hudsons, and Selkirks alike all were seen on freight trains in their later years. All three Selkirk subclasses were reassigned to freight service east of Calgary in 1952.

After a well-publicized "farewell" round trip led by H1d 2857 from Toronto to Port McNicoll, Ont., on June 5, 1960, the last CPR revenue run for a Bowen semi-streamlined engine—another Royal Hudson—occurred in the anonymity of Montreal commuter service later that spring.

Four Royal Hudsons, including celebrity 2850 at the Canadian Railway Museum in Delson, Quebec, survived scrapping. Two, 2839 and 2860, went on to excursion careers of varying scope, including in the U.S., while 2858 became an Ottawa museum piece. F1a Jubilees 2928 (Delson) and 2929 (Steamtown in Scranton, Pa.), and Selkirks 5931 (a Calgary park) and 5935 (Delson), are also preserved, although none of those four has been restored to operation. Regrettably, none of Bowen's original semi-streamlined quintet—the F2a Jubilees of 1936—survived.

The PINNACLE *of service*

For a young Santa Fe firreman, working a 4-8-4 on a top passenger run was as good as it got in 1943

BY **JACK O. ELWOOD** • PHOTOS BY **STAN KISTLER**

BY THE WARTIME YEARS of 1943-44, I'd risen to become a senior locomotive fireman for the Atchison, Topeka & Santa Fe, on its Los Angeles Division. When you reached that status, you got the pinnacle of assignments—passenger service, namely Santa Fe's top trains, the *Super Chief*, *El Capitan*, *Chief*, *California Limited*, *Grand Canyon Limited*, *Scout*, and *Fast Mail*. Come along with me on a typical trip of this era, from Los Angeles to Barstow, Calif.

In the morning my telephone had rung, and the crew clerk had told me "You're called for number 20, the *Chief*, on duty at 11 a.m. at Redondo Junction roundhouse, with engineer J. P. Murray and engine 3785." It couldn't be any better—a good train, a great engineer who had taught me a lot, and a locomotive that was the pride of the fleet—the last of Santa Fe's 10-member 3776 class of 4-8-4's, delivered by Baldwin in 1941.

AT THE ROUNDHOUSE

Upon arriving at the roundhouse, as a fireman my first order of business was to fill out the hours-of-service log, registering my engineer's name and my own on the outbound sheet for train 20. I checked my watch for accuracy against the standard railroad clock, then looked at the inbound work reports for engine 3785 to see if there'd been any defects reported and if so, whether they'd been corrected.

Then it was out to the locomotive on the outbound lead track. I climbed into the cab and checked the boiler water level in order to build up steam pressure and be ready for departure. This check was made by looking at the water-gauge glasses and gauge cocks, making sure the glasses were blown out so the indication of the boiler's water level would be accurate. Then I checked the firebox for water leaks and to see if any firebricks were cracked or down. I then set the firing valve to build up steam pressure, filled the hand oiler, and made sure a ball of waste was ready (waste was a shredded cloth material used to wipe off machinery).

I made sure the tallow pots (containers for valve oil) were full. Then, using the measuring rod on the tender, I checked the fuel-oil level. Next I went to the rear of the tender to make sure the tank was full of water.

Back in the cab, I took the squirt hose (which provided a steam and water mixture at boiler pressure) and washed off the cab deck, in and around the engineer's and fireman's seatboxes, and the boiler backhead piping and valves, as well as the tallow pot and hand-oiler tray. The mixture of steam and water did a good job of cleaning the cab, and it dried quickly.

About this time, the engineer would normally show up. The fireman would help him hoist his grip (a heavy metal box with all articles necessary for his trip) from the ground up the ladder and into the cab, and place it behind the engineer's seatbox. The fireman would give the engineer the hand oiler with the ball of waste for him to oil around and inspect the running gear.

While the engineer was doing that, the fireman would tend to the fire, getting steam up to operating pressure. When the engineer completed his inspection and was back in the cab, he'd check over his side of the cab, make the air-brake test, check the sanders and gauges, and adjust his seat to make himself comfortable. At that point, No. 20's crew would be ready to leave the roundhouse.

TO UNION STATION

As engineer Joe Murray slowly opened the throttle on 3785, with the cylinder cocks open to rid the cylinders of accumulated condensation, we began to move. He gave one long and four short blasts on the whistle to notify the operator in Redondo Junction tower that we were ready to enter the main line and go to Los Angeles Union Passenger Terminal. As soon as the "op" lined us up, we were on our way.

Engineer Joe Murray, the author's mentor, stands beside the 3776-class 4-8-4 he's run on the *Chief* into Pasadena in 1946.

Santa Fe's main line followed the Los Angeles River, which gave us an early opportunity to use the boiler blowoff cocks. Older locomotives had side blowoff cocks, but newer locomotives such as 3785 were equipped with a "submarine" blowoff cock under the cab, through which water, steam, and sludge would be discharged between the rails under the engine. The older side blowoff cocks required a clear area, so nothing close to the track would be damaged by high-pressure steam being blown out. This intermittent blowout procedure is necessary to rid the boiler of sediment and foam that collects in the mud ring at the forward point of the boiler, which ensures that the boiler water is clean and can be more readily converted to steam.

When we arrived at LAUPT, a terminal towerman lined us into the

The fireman leans out from Santa Fe's big 4-8-4 3785 as it sails up Cajon Pass on October 8, 1950, with second No. 19, carrying overflow traffic from No. 7, the *Fast Mail*.

A young Santa Fe fireman, a contemporary of author Elwood but whose name is unknown to us, has his hand on the damper control in the cab of 4-8-4 3781. The firing valve for the oil-burner is above it.

In one of railroading's most classic scenes, the train crew goes over their orders beside 4-8-4 3782 at Los Angeles Union Station in June 1948. The "men at work" blue flag protects carmen checking the train.

In a wonderful panoramic view of Santa Fe's Redondo Junction roundhouse in L.A. in 1948, workers pose by 4-8-4 3785 during servicing. To the right is a pioneer EMC diesel, built in 1935 as *Super Chief* B-B-trucked motor 1A, rebuilt in 1937 into a booster, then as 1B-1B-trucked high-nose cab unit No. 10, then into this B-B local freight unit 2611. A high-hood Alco diesel switcher is also visible, at far right.

depot track where train 20 was made up. A locomotive could couple onto its train only if everything was clear and the blue flag had been removed. The blue flag (or at night, a light) was a signal to protect people working on, near, or under the cars and could be removed only by the person who placed it there. After the engine coupled on, carmen would connect the air hoses and steam and signal lines between the tender and the first car, and the consist would be complete.

When the fireman received a signal that this was done, he'd open the steam heat valve in the cab to allow steam to feed into the trainline; this provided hot water and heat to the cars. The *Chief* was usually 12 to 14 cars, so it was necessary for the fireman to maintain the maximum steam pressure at all times after the engine had coupled on.

Next was the air-brake test. After the air pressure on the engineer's gauge indicated a fully charged train line, he applied the train air brakes. The carmen then walked the train on each side, making sure each car's brakes had applied. Once at the rear of the train, a carman signaled the engineer to release the brakes. The carmen then walked the train again, forward, making sure each car's brakes had released. During this procedure, the engineer would be checking the trainline pressure leakage on his air gauge, and if there was no leakage greater than 5 pounds per minute, the brake system was OK for train departure.

About this time the conductor would come up to the engine and give the engineer his running orders, and they'd compare their watches to see they both had the correct time. The engineer and fireman would read the orders, and in the case of train 20, since we would be operating on single track, the orders would include a register check to determine if all opposing scheduled trains had arrived at Broadway, the end of double track as we'd head east. After the crew had read all the orders and messages, determining that No. 20 could leave the depot, the engineer would await the highball from the conductor. Upon receiving it, the engineer opened the throttle, and the *Chief* was on its way to Chicago.

SECOND DISTRICT

All this time, as fireman, I would have built up my fire to reflect maximum steam pressure (300 psi for the 3785), and I'd have the boiler water up to proper level. In about a mile and a half, our train would start up the grade from Water Street to Highland Park, and full steam pressure was necessary. There was not too much time for me to feel the engine out.

There were many details to firing a locomotive on the road, such as observing the water glass and periodically operating the water pump or injector to replenish water in the boiler. Meantime, he had to be the engineer's "eyes" forward along the left side of the long boiler. Going around a left-hand curve, there were block and train-order signals a fireman would see well before the engineer could.

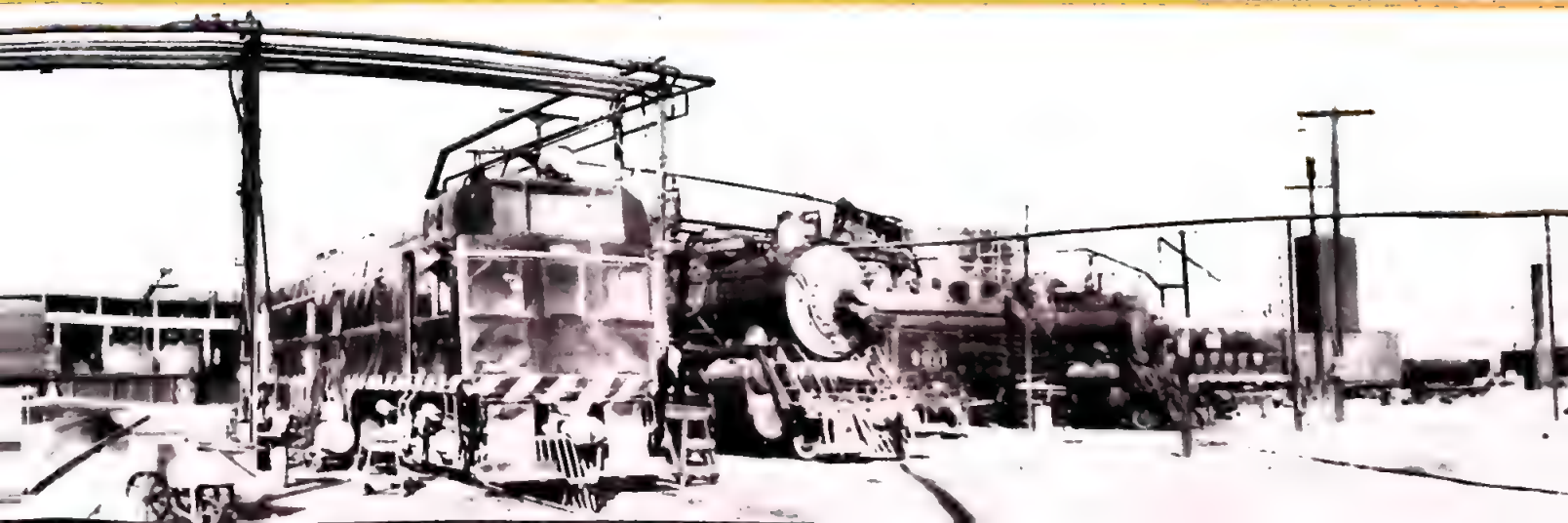
Once out of LAUPT with No. 20, we passed the stations of Monrovia, Butler, and Kinkade. No. 20 carried a Railway Post Office car, and Monrovia was a mail pouch pick-up station. The pouch was picked up on the fly on the left (north) side of the train, and the fireman had to know the location of such mail cranes so he wouldn't be leaning out of the cab window as he passed one because of their close clearance. On this Second District from L.A. to San Bernardino, No. 20 had only two regular stops, Pasadena and Pomona (a flag stop), but on occasions it would make a stop at Monrovia or Azusa for special passengers.

Maintaining track speed of 65 mph (except for restricted curves) through Azusa, we'd pass Glendora and San Dimas and make our station stop at Pomona. Engineer Murray would ease off 3785's throttle before going into the left-hand curve prior to Pomona, and I'd look ahead to call out to him if we had a red or clear train-order board. Sometimes we'd receive a number of passengers at Pomona, losing a few minutes off our schedule. When we did, I knew that Joe would work the engine hard right out of there, so I'd have the steam gauge right on the peg so that before we'd passed Claremont, we'd be up to 65, gaining back some of those lost minutes. Upland, the next station, had a 30-mph road crossing just west of the depot. This marked the Los Angeles County line and the end of our 65-mph speed limit.

After the engine passed this crossing, Joe would yell, "OK, Jack, let's go to town!" He'd open the throttle as I'd open the firing valve. The 4-8-4 would respond with a roar, and after rounding the 70-mph curve east of Upland, we'd be flying by Cucamonga at 90, or better if we had time to make up. This was the fun time—there was no greater thrill than to be riding this thundering monster, feeling her power as she'd hit a low joint in the track and dip and sway. We'd have to make up any schedule deficit between Cucamonga and Rialto, because from Rialto to San Bernardino the speed limit was 30 mph. This, however, gave the fireman an opportunity to prepare his fire and boiler water level for the 5-minute station stop at San Bernardino.

Because much of the water used for locomotive boilers in southern California had a high alkali content, when we'd take water, we'd also mix a measured amount of compound into the tank to keep the foaming of the water

PHOTOGRAPHER UNKNOWN; STAN KISTLER COLLECTION



ABOVE: WENDELL H. KINNEY

In 1946, No. 20 crosses Arroyo Seco Speedway between L.A. and Pasadena (above) and drifts through East Pasadena behind doubleheaded 3782-3783 (right). With a helper not needed here, the second engine is likely deadheading east for an extra west.

to a minimum. Just before the San Bernardino station stop, the fireman would be up on the back of the tender to spot the engineer so the spout would line up properly with the water manholes and get the water flowing immediately. The short 5-minute stop required every function to proceed without delay. In addition to taking water, a helper engine had to couple onto the front of our locomotive, and another air-brake test had to be made because the helper engineer now had control of the train brakes.

When the tender was full of water, the fireman would swing the spout back in the clear, hurry back down into the cab, and build up steam pressure. Upon leaving San Bernardino, it was an ascending grade up Cajon Pass for the next 27 miles to Summit, full throttle all the way. A locomotive such as the 3785 would use 70 to 120 gallons of water per mile.

GOING UP CAJON

Upon receiving the highball, the *Chief* would ease around the 20-mph curve east of the depot, both engines working with sharp exhausts. The helper engineer would set the train brakes, making a running air test to determine that the brakes were operable. With an OK from the rear of the train that the brakes had applied and released, both engineers went to full throttle. As the exhausts reverberated along the lineside buildings, with smoke and steam rolling high into the sky, both firemen tried for the right combination of atomizer and firing valve to achieve perfect combustion.

Around the big curve at Highland Junction things would settle down. Both engineers had achieved the proper valve setting and both locomotives would be working at maximum efficiency. To get the train to Summit on schedule, the firemen would watch their water glasses and slowly raise the boiler water level. The engineers periodically would apply sand under the drivers when rounding sharp curves to prevent the wheels from losing adhesion on the grade. If everything worked fine, the trip up Cajon Pass was one of watchful waiting and preparation for Summit.

Upon arriving at Summit, the helper engineer would stop the train short of the crossover to the eastbound siding, assuming it was clear (if not, he'd stop clear of the stub track behind the Summit depot). If the stub track was to be used, the helper fireman would run up to the switch, and 20's fireman would go forward to uncouple the helper engine. The helper would pull past the stub track switch, the helper fireman would line the switch for the stub, and the helper would back into the clear. The helper fireman would then line for No. 20 to proceed east.

This cooperative approach gave the *Chief* the least delay.

With the helper engine cut off, Joe Murray and the 3785 were once again in charge. Another air-brake test had to be made, and when the highball came from the rear car, we were again on our way. Around the curves at Lugo, the speed limit was 40 mph, but after that, the fun began again! Joe would open the throttle wide, and I'd open the firing valve. In a short time we'd be up to 90 mph through Hesperia. At Hesperia's east end, Joe would set the brakes for a 60-mph curve; we'd then go through Frost at 40 and ease down to 30 into Victorville, a flagstop for No. 20. During World War II, with George Air Force base located nearby, the *Chief* often made a Victorville stop.

LAST LEG TO BARSTOW

Leaving Victorville, Joe would say, "OK, Jack, it's your turn now. Take us to Barstow." Those were the magic words! Since we'd stopped at Victorville, we were again a bit late. Joe and I had worked together on many trips, and he had taken me under his wing and taught me how to run a passenger train. I was 23 years old and thrilled with my situation.

From Victorville, you had to get moving quickly, as every minute counted if you wanted to go into Barstow on time. East of Victorville, there was a 40-mph curve over the Mojave River bridge, then a 60-mph curve into Oro Grande. When the rear of the train came out of that curve, you'd have the brakes releasing and the throttle wide open, reaching for 90, or more if you needed to make up time. There were restricting curves at Helendale and Hodge, then you'd sail into Lenwood and on into Barstow, passing the tower and rolling into the depot, hopefully on time at 3:45 p.m.

Going into Barstow, the fireman would have at least a half-full water glass and about 5 pounds less than maximum steam pressure so the safety valves would not go off during the station stop. Because the tender again was to be filled with water at Barstow, the arriving engineer would have to bring the train to a stop at the water spout. To come in at 20 mph and make the correct spot smoothly took skillful manipulation of the throttle and train brakes. Joe started showing me how to do this the first time I began running the train into Barstow. On every trip I would develop more of the technique, and soon I was able to do it well, although not without a lot of anxiety.

F. J. PETERSON

With smoke flying high from the raised stack extension, 3781 starts up the Cajon grade near Victorville with a 14-car No. 19 in October 1945. Could author Elwood be firing?

Santa Fe ran its big passenger engines perhaps the greatest distances of any railroad, and the 3785 would go through to Kansas City, almost 2200 miles from L.A. via Pasadena, Calif., and La Junta, Colo. Hence, arriving in Barstow, we would give the outbound crew notice of any problems: how she was steaming and riding, the accuracy of the speedometer, or anything else pertinent to operation. Then Joe and I would head for the locker room to clean up and fill out our reports. Since we'd be in Barstow for the night, we'd walk over to the reading room and sign up for a sleeping room, and later go to the Harvey House for dinner.

The reading room was always full of freight and passenger crews, as Barstow was the terminal for men working in three directions, to Los Angeles, Needles, and Bakersfield. There was an almost constant card game going on, and spirited arguments that can only go on among a bunch of railroaders who claim to be the final authority on any subject known to man. There was a serious side, too, though, as many of us young firemen, on our layover time, would study together for our engineer's promotion examination. Many lasting friendships were formed in these situations.

When we'd come in on No. 20, Joe and I would stand for either its westbound counterpart, No. 19, or No. 17, the *Super Chief*, at about 4:30 or 5 a.m. back to Los Angeles. Although both trains had lightweight car consists by this time, 19 still rated a steam engine while 17 had diesel power. Although the diesels were gradually taking over from our beloved steam locomotives, if we caught 17, we were able to hone our skills on the new type of motive power.

Six decades have passed since this typical trip I have described took place. The railway is now Burlington Northern Santa Fe, and the old Second District of the Los Angeles Division, on which No. 20 operated to San Bernardino, no longer exists as a through route, and in fact has a new light-rail transit line on its west end. The 20-mph curve just out of San Bernardino station has been realigned, and a line relocation at Summit eliminated the depot and totally changed the look of the place. On the First District at Barstow, there is a big, modern yard, and the main line into the depot has been realigned. Although the trip I described from so many years ago would be almost unrecognizable in detail today, heavy mainline railroading on the route lives on, creating memories for today's train crews many years hence. But I wouldn't trade my experiences on those 4-8-4's for anything! ■

Steam Glory
PHOTO SECTION

UNMISTAKABLY ESPEE: Oil smoke hangs in the distance on August 31, 1955, as two Southern Pacific cab-forward 4-8-8-2s team up on a freight at Madeline, Calif., south of Alturas on SP's lonely Modoc line. Up front is AC-11 4251, while 95 cars back is AC-10 4223. Born of smoke problems in Sierra snowsheds, cab-aheads also came in 4-6-6-2 and 2-8-8-2 versions. They were unique to the Espee which had 195, all built by Baldwin.

STEAM'S GREATEST LOSS: It's November 1950, and diesels have taken over the top assignments, but New York Central J-3a Hudson 5433 can still "show 'em how it's done" as she flies down the Water Level Route with an eastbound secondary train a few miles west of South Bend, Ind. Unfortunately, not one of the Central's 275 superb 4-6-4's was saved for posterity.

LINN H. WESTCOTT

FAMILIAR STORY: Built by Baldwin in 1923 as passenger engines, Great Northern's 28 P-2 class 4-8-2's were successful, but as on several carriers, eventually bowed to 4-8-4's. By the mid-1950's, when the photographer caught up with the 2526 somewhere in Minnesota, they were rolling freights across the prairies.

GEORGE KRAMBLES PHOTO, KRAMBLES-PETERSON ARCHIVE

PRAIRIE HAULERS: Baldwin's first 2-10-4's were 12 for Chicago, Burlington & Quincy in 1927. Initially put in southern Illinois coal service, the eventual 18 M-4 class engines were rebuilt in the 1930's for higher-speed work, evidenced by 6316 in November 1955 with mostly refrigerator cars, on the last leg of a Chicago-Galesburg (Ill.) run.

BOB MILNER

JACK POLARITZ COLLECTION

B&O'S BIGGEST: Running on Pittsburgh & Lake Erie by trackage rights, a Baltimore & Ohio EM-1 2-8-8-4 on a freight drag is flanked by a P&LE Alco PA on a passenger train at New Castle, Pa., in April 1952. The 30 EM-1's came from Baldwin in 1944-45, lasted on Ohio coal trains till '58.

TOP OF THE LINE: Fourth of 20 4-8-2's turned out by the road's own Paducah (Ky.) shops during 1942-43, Illinois Central 2603 hustles north through the junction of Otto, south of Kankakee, Ill., on June 6, 1954, with a train of Chicago-bound refrigerator cars most likely full of bananas.

MERT LEET

RUSS PORTER

"BIG EMMA": Louisville & Nashville's M-1 2-8-4's were its largest steam power. Built by Baldwin (20 in 1942-44) and Lima (22 in 1949), their large size kept them in Kentucky. Four were equipped for passenger work; the 1962, on a Kentucky Derby special, rests at Louisville on May 2, 1956.

ALFRED S. ARNOLD

JACK PFEIFER PHOTO, AL CHIONE COLLECTION

MINUTE MAN MOUNTAINS: Boston & Maine's last new steam class was the R-1 of 1935, a 4-8-2 for fast freight. B&M got 18 from Baldwin through 1941, the last 5 of which had centipede tenders. The road dieselized its freights early, and sold 12 R-1's to B&O in 1947. At Ewing, Mass., No. 4104 rolls toward East Deerfield in 1940, seven years before she changed hands.

OVERLAND ROUTE RACERS: Chicago & North Western 4-6-4 4006 gets out of Council Bluffs, Iowa, with the *Chicago Express* on July 6, 1952. Built by Alco in 1938 to haul standard trains (*i.e.*, those other than articulated diesel streamliners) between Chicago and Omaha, C&NW's nine E-4's shared many specs with Milwaukee's F7 Hudsons, including 84-inch drivers.

PHOTO SECTION

FLYING HI: Barely slowing down for the Chicago & North Western diamonds at Mayfair in Chicago, Milwaukee Road F7 Hudson 102 storms into the Windy City in May 1941 on the last leg of its trip from Minneapolis with *Morning Hiawatha* No. 6. The *Hi* made the 421-mile run in 6 hours, 50 minutes with eight intermediate stops. Speeds of 100 mph were commonplace.

LINN H. WESTCOTT

UNIVERSAL U-3-b: The metal "extra" flags, triangular numberboard housing, cast name/numberplate, and smokebox-mounted whistle were among the signature features of Grand Trunk Western's 25 dual-service U-3-b 4-8-4's, built by Alco in 1942 and patterned after parent CN's Northerns. The Trunk's U's gained fame for their longevity, serving into the 1960's.

EDWARD THEISINGER

FUTURE STAR: Reading Company 2102 was just another T-1 4-8-4 on December 23, 1952, when she was close to stalling with a 95-car eastbound freight at Fanwood, N.J., on the Jersey Central. The road crafted the 30 T-1's in 1945-47 from heavy 2-8-0's. After dieselization, it used three of the freighters—2124, 2100, and 2102—in a five-year series of "Iron Horse Ramble" excursions, and they survive today.

MERT LEET

85 STRONG: From the last batch of 20 R-67B class 4-8-4's built by Alco in the mid-1940's, Rock Island 5111 is ready to depart Blue Island, Ill., in August 1951. The Rock, which had 65 other R-67B's dating from 1929-30, bought more 4-8-4's than any other U.S. road. Engines built for the Milwaukee Road and Delaware & Hudson during World War II used R-67 specs.

FRISCO FREIGHT JOB: The St. Louis-San Francisco Railway had 25 4-8-4's: 3 oil-burners for passenger work, 22 coal-burners for freight, all built by Baldwin in 1942-43. The passenger engines were blue and white, while the others wore a FRISCO FASTER FREIGHT logo on their tenders. In a rare color photo from World War II taken by the engine's fireman, nearly new 4522 is in the siding at Aurora, Mo., with train 33.

MILLARD MORROW PHOTO, CHARLIE DISCHINGER COLLECTION

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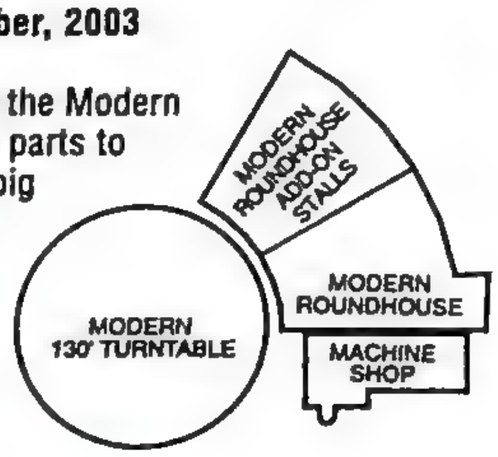

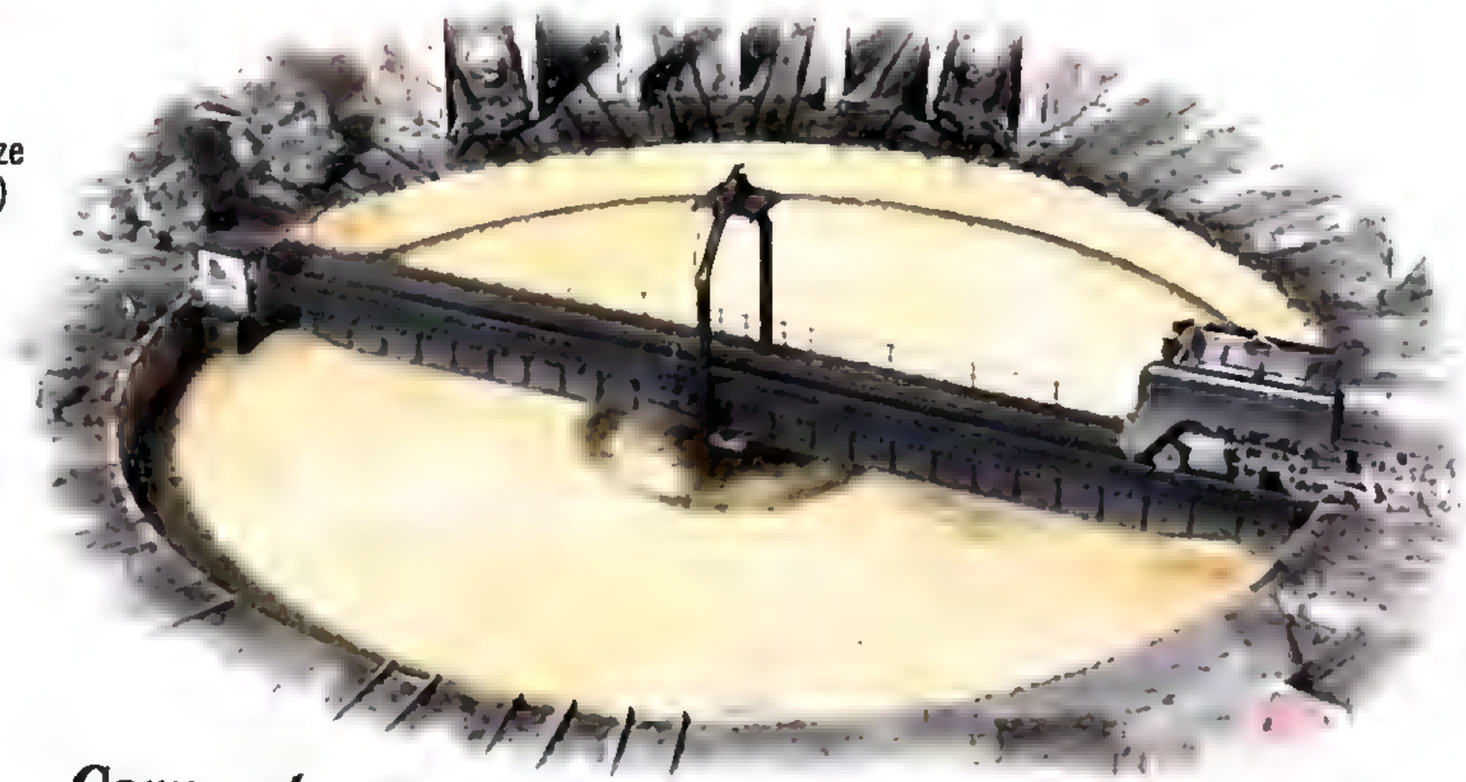

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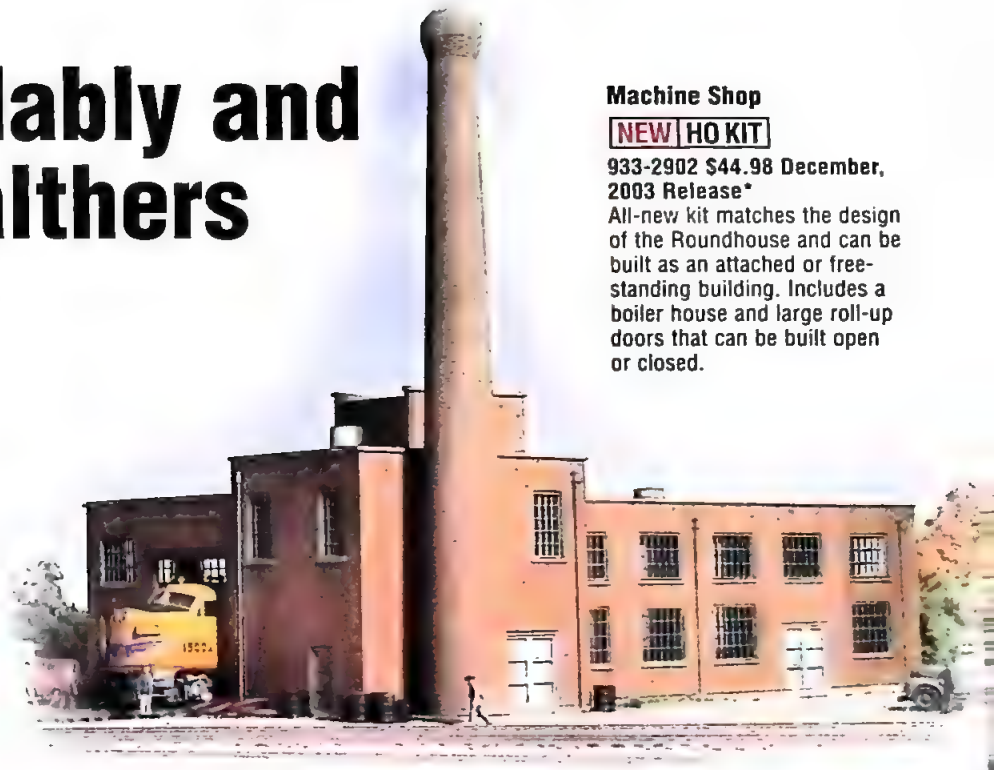

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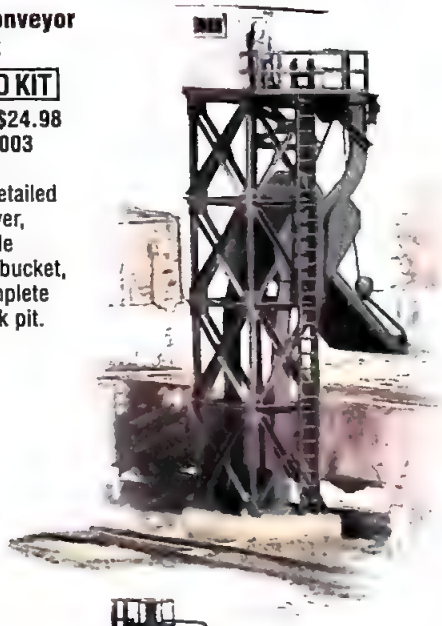

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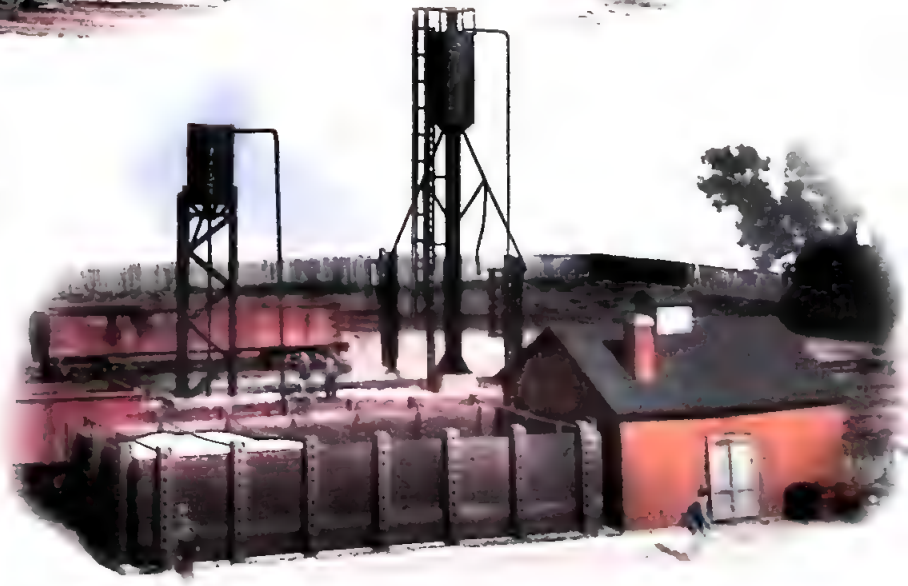


Three cylinders to the rescue

When New Haven's Alco FA diesels needed a boost on rainy days, steam was there to help

BY **J. W. SWANBERG** • PHOTOS BY **KENT W. COCHRANE**

Leaking steam into the moist air, R-3-a 3558 crouches under the Beacon line bridge at Hopewell Junction, waiting to help a diesel freight east.

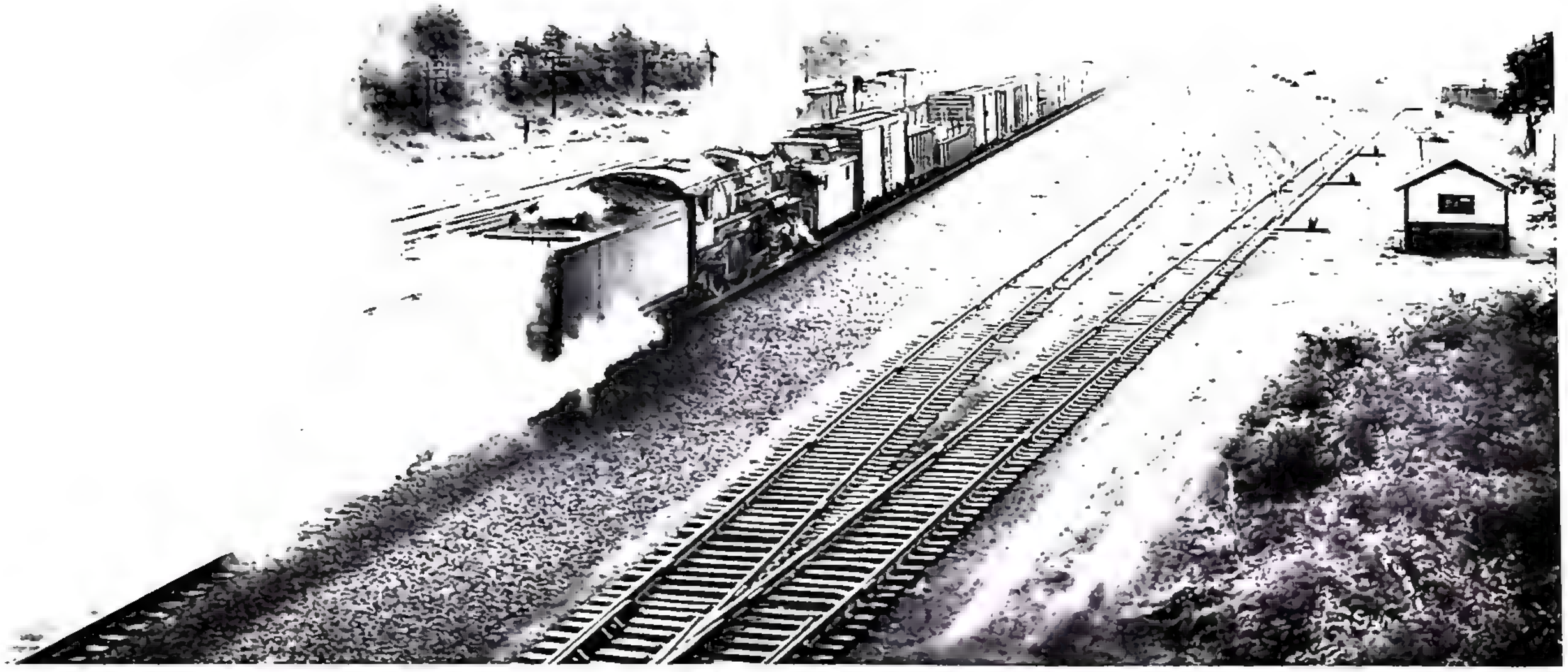
THE NEW HAVEN Railroad bought 13 freight-service 4-8-2 locomotives, Nos. 3550-3562, from Alco in 1926 and '28, but they suffered a star-crossed beginning. For openers, they had McClellan boilers, with water-tube fireboxes which soon developed incurable tube-end and cold-air leaks. They also featured Alco's ballyhooed three-cylinder design, wherein an additional center cylinder drove a cranked driver axle via an inside main rod, an arrangement thoroughly disliked by everyone who had to work on the dirty and inaccessible inside machinery.

The firebox problem was eliminated in 1929 by the expensive replacement of the water-tube design with the conventional staybolted type. The New Haven further considered rebuilding the locomotives to two-cylinder machines, but as the Depression was setting in, deemed this cost-prohibitive and so learned to live with the engines as they were.

The hard-to-maintain locomotives did produce impressive results, hauling 2-10-2-size hotshot freights at passenger-train speeds down the Shore Line from Boston to New Haven and

The crew in caboose C-512 gets an earful of three-cylinder stack talk as the 3558 puts her shoulder to New Haven-bound tonnage in July 1950.

ALL PHOTOS BY KENT W. COCHRANE, T. J. McNAMARA COLLECTION, COURTESY J. W. SWANBERG



Mighty clouds of joy: NH 3558 shows she still has what it takes, shoving hard out of Hopewell Junction. Eight months later, she was retired.

Despite a troubled beginning, this 4-8-2 made her exit every inch a star.

continuing right through over the hilly freight route to Maybrook, N.Y. At 275 miles, this was the longest freight run in New England. Meanwhile, 50 lumbering 2-10-2 Santa Fe types handled New Haven's routine tonnage between Cedar Hill Yard in New Haven and Maybrook. The 2-10-2's also worked in pusher service on the route's eastbound 1.16 percent grade out of Hopewell Junction, N.Y.

The arrival during World War II of 60 dual-service Alco DL109 diesels bumped the three-cylinder 4-8-2's from Boston-Maybrook service, and in 1947, 15 new three-unit Alco FA sets finished off the 2-10-2's. The New Haven's public relations department stated that, "The 4500 horsepower Diesel-electrics now used in the Maybrook-Cedar Hill service eliminate the need for pushers."

Well, almost. It turned out that the FA's had trouble on the grade out of Hopewell Junction when rainy weather caused excessive wheel-slip on the wet rails.

Steam was not quite gone from the New Haven—it still handled Old Colony commuter trains out of Boston, for example—and three-cylinder 4-8-2 3558, displaced from mainline service, was laboring on lowly Maybrook Yard jobs, shoving cuts of freight cars over the hump (an acknowledged advantage of the three-cylinder design was less slipping at slow speeds). Her road pilot had been replaced by switcher-style footboards, and the former freight speedster seemed destined to an ignominious end.

Not so—the 3558 went out in style! On rainy days, the sure-footed 4-8-2 was dispatched from Maybrook east to Hopewell Junction to help FA-powered trains over the hill. Look at these photos, taken by the late Kent Cochrane at the old pusher station on a rainy day in July 1950. The beetle-browed 3558 awaits the next eastbound freight, then couples on behind its steel caboose and puts on a grand, steamy display as she shoves the long train up the slippery rails and through the clouds toward Reynoldsville Summit. Despite a troubled beginning, this 4-8-2 made her exit every inch a star. ■

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THE CALIFORNIA ZEPHYR RETURNS— April 15-18. The original "CZ" will operate again over the High Sierra to Reno, Nevada for the Western Pacific 2004 Convention. Mark you calendars- this is a MUST DO event!

GREAT CANADIAN RAIL ADVENTURE— April 22 to May 6. A grand railroad tour of British Columbia and Alberta including Vancouver Island. Features a four day charter steam excursion over the mainline of the Canadian Pacific from Calgary to Vancouver and a two day charter on the British Columbia Railroad.

CANADIAN STEAM EXPRESS— April 26 to May 3. Features a four day charter steam excursion over the mainline of the Canadian Pacific between Calgary and Vancouver with photo run-bys plus a two day charter over the British Columbia Railroad using two FP7's.

CABIBOO SPECIAL— May 1-2. Two-day charter over the British Columbia Railroad out of North Vancouver using two CP painted FP7's.

McCLOUD STEAM SPECIAL— May 15. Enjoy a full day steam excursion between McCloud and Burney roundtrip on the McCloud Railroad in Northern California.

WHITE PASS STEAM SPECTACULAR— June 10-13. Charter steam for the railfan photographers over the White Pass & Yukon Railroad with different consists each day.

ALASKA RAILFAN ADVENTURE— June 10-20. Come north with us to Alaska and enjoy the many delights of railfanning including our White Pass Steam Spectacular.

DOMES TO THE PACIFIC NORTHWEST FOR THE NMRA CONVENTION— July 2-8. We will have five private rail cars coupled onto Amtrak's "Coast Starlight" from Oakland and arriving Seattle on July 3 for the model railroad convention. Our railcars will then depart Seattle on July 7 for the return to Oakland, California.

DOMES TO CANADA WITH THE NMRA— July 4. We will have the "California Zephyr" Vista Dome cars "Silver Lariet" and "Silver Solarium" coupled onto Amtrak's Talgo from Seattle to Vancouver and return.

STAMPEDE PASS RAIL ADVENTURE— July 6. Charter train from Seattle to Cle Elum and return over the old Northern Pacific's Stampede Pass, now operated by the BNSF. Final arrangements pending at the deadline for this ad.

PACIFIC COAST DOMES— August 7-9. Ride our dome cars up the California Coast from LA to San Luis Obispo and return, including the weekend in Cambria-San Simcon visiting famous "Hearst Castle". Also we have an option to ride all the way to Oakland and return if you like.

GREAT PERUVIAN RAIL ADVENTURE— August 21 to September 2. Grand railroad tour of Peru features six breathtaking train rides over some of the most rugged lines in the world high in the Andes.

DOMES TO FEATHER RIVER RAILROAD DAYS— August 27-29. Great family weekend onboard our dome cars from the San Francisco Bay Area to Reno, Nevada and a full day in Portola at the annual "Railroad Days" event.

CHINA STEAM SPECTACULAR— September 19 to October 2. Featuring the last of the mainline steam in China.

RIO GRANDE PHOTO FREIGHT— September 27-28. Two day steam photo freight on the Cumbres & Toltec in the Rockies.

DURANGO PHOTO SPECIAL— September 29. Charter photo special out of Durango, Colorado to Cascade Canyon.

NEVADA NORTHERN RAILFAN SPECTACULAR— October 2-3. Charter steam with a 4-6-0 and 2-8-0 pulling different consists including a doubleheader out of East Ely, Nevada.

NEW ENGLAND FALL COLORS RAIL ADVENTURE— October 2-9. Railroad tour of New England during the fall colors. Tour will visit Massachusetts, Maine, New Hampshire and Vermont.

THE OLD PATAGONIAN EXPRESS— October 28 to November 12. Featuring several days on the 251-mile Esquel line in Argentina, which is the last 100% steam worked route in South America. The entire line will be open again in 2004.

MEXICAN COPPER CANYON RAIL ADVENTURE— November 11-17. Enjoy rugged Copper Canyon in Mexico onboard our all-Pullman charter train. Tour start and ends in Tucson, Arizona.

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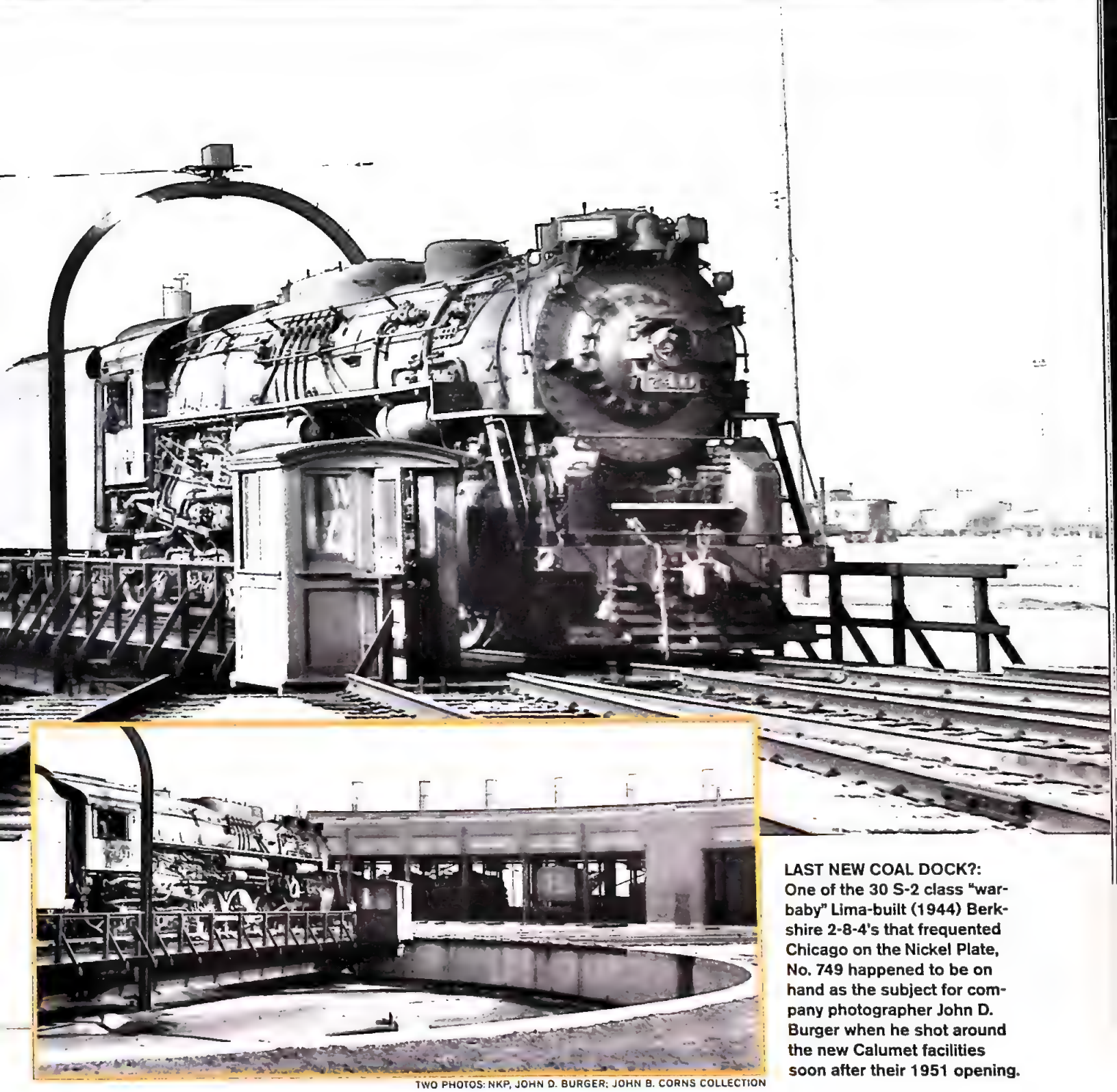
Berkshire LAUNCHING PAD

Along the east shore of Chicago's Lake Calumet was a most modern locomotive servicing area

BY **TONY KOESTER** AND **RICHARD P. YAGER**



TWO PHOTOS: NKP, JOHN D. BURGER; JOHN B. CORNS COLLECTION

LAST NEW COAL DOCK?: One of the 30 S-2 class "war-baby" Lima-built (1944) Berkshire 2-8-4's that frequented Chicago on the Nickel Plate, No. 749 happened to be on hand as the subject for company photographer John D. Burger when he shot around the new Calumet facilities soon after their 1951 opening.

THE NEW YORK, *CALUMET* & ST. LOUIS? That name doesn't muster the same panache as "New York, *Chicago* & St. Louis," but for the latter-day NYC&StL, better known as the Nickel Plate Road (NKP), it would have been more to the point. After 1951, Calumet—a yard and terminal hard by the eastern shore of its namesake lake in far southeastern Chicago—was where a bevy of eastbound hotshots was launched daily behind some of the finest engines Lima Locomotive Works ever built.

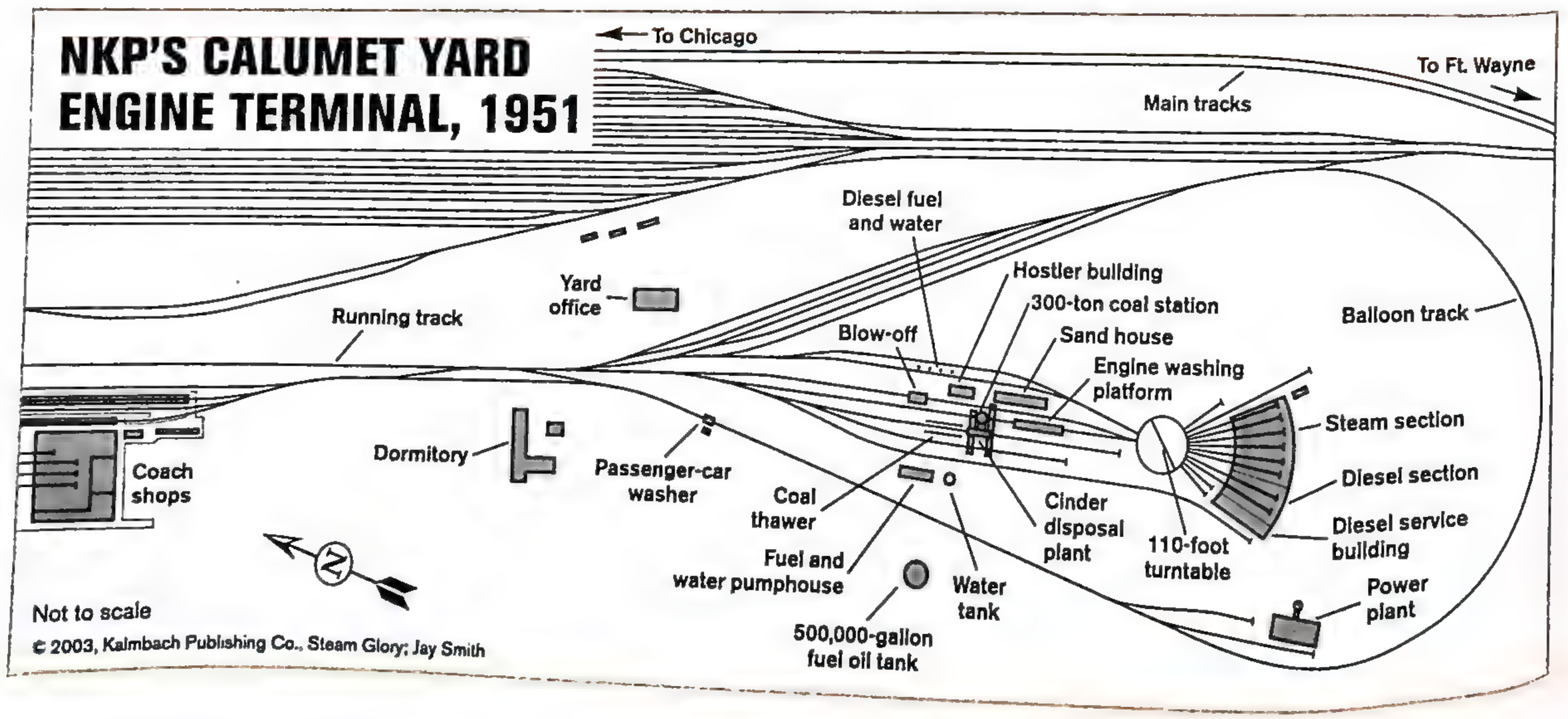
It wasn't always that way. Nickel Plate Chicago Division timetables measured distance from La Salle Street Station in downtown Chicago, but NKP's main shops and westernmost yard were originally located 11.3 miles south at a place called Stony Island. The road's 16-stall roundhouse, 65-foot turntable, and main repair shop, which dated to 1882 when the railroad began operations, were built at Stony Island Avenue and 93rd Street, hence the name.

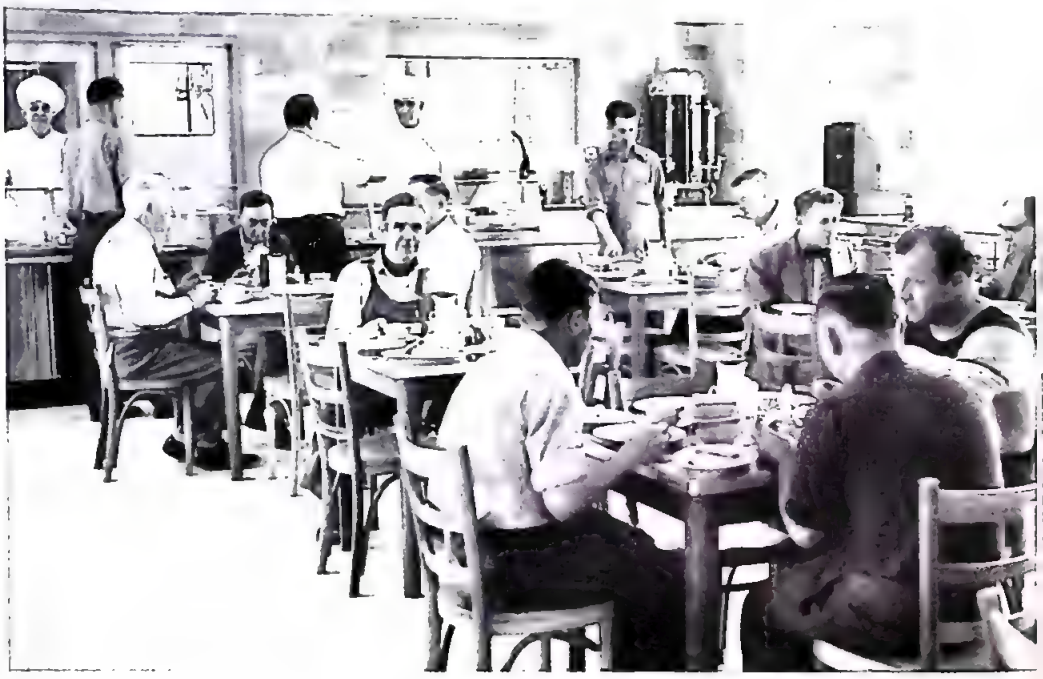
In 1924, in an effort to cope with a lack

of physical-plant improvements during the era of Vanderbilt control, Nickel Plate built a 2200-car yard on 131 acres acquired two years earlier near Lake Calumet. Chesapeake & Ohio, affiliated with NKP by common ownership under Cleveland's Van Sweringen brothers, also used this yard and the Stony Island engine terminal, reaching it on NKP trackage rights from Hammond, Ind.

Nickel Plate's shops and engine terminal, though, remained at Stony Island, north of the yard, for another 27 years. What once had been a state-of-the-art facility was long overdue for replacement by the time the first of the famed Van Sweringen Berkshire 2-8-4's, which were scaled-down versions of C&O's potent T-1 class 2-10-4's, made their way west to Chicago. Putting Super-Power 2-8-4's in the dirt-floored, soot-coated, 4-4-0-era Stony Island roundhouse was like keeping F-117 stealth fighters at a grass airstrip.

All that changed in the 1940's and '50's when NKP President John Wysor Davin's modernization program swept over the railroad. There were already hints of what it would take for Nickel Plate to earn its "High Speed Service" reputation. Conneaut, Ohio, for example, got a towering 500-ton concrete coal dock in 1924, and a similar one rose at NKP's hub of Bellevue, Ohio, a year later. A





THREE PHOTOS, NKP, JOHN D. BURGER, CLASSIC TRAINS COLLECTION

third one went up in 1937 at Frankfort, Ind., another hub where NKP's former Lake Erie & Western and Clover Leaf mains crossed.

When it became clear that Robert R. Young's plans to consolidate NKP, Pere Marquette, and Wheeling & Lake Erie (which NKP later leased) under the C&O umbrella were doomed by strong opposition from preferred stockholders, Young gave NKP its independence. His sights were focused elsewhere, and NKP had become a distraction.

Young's largesse was Davin's windfall. He took the NKP helm in 1944, and the next six years were, to quote NKP historian John A. Rehor, "the most dynamic in the road's history." Davin left his successors "an expanding facility fully a decade ahead of its competition," Rehor wrote. That competition included New York Central and one-time Van Sweringen partner Erie. NKP had its incomparable Berkshires, with more on the way, but much of its physical plant, including the shops and roundhouse at Stony Island, dated to the railroad's earliest years.

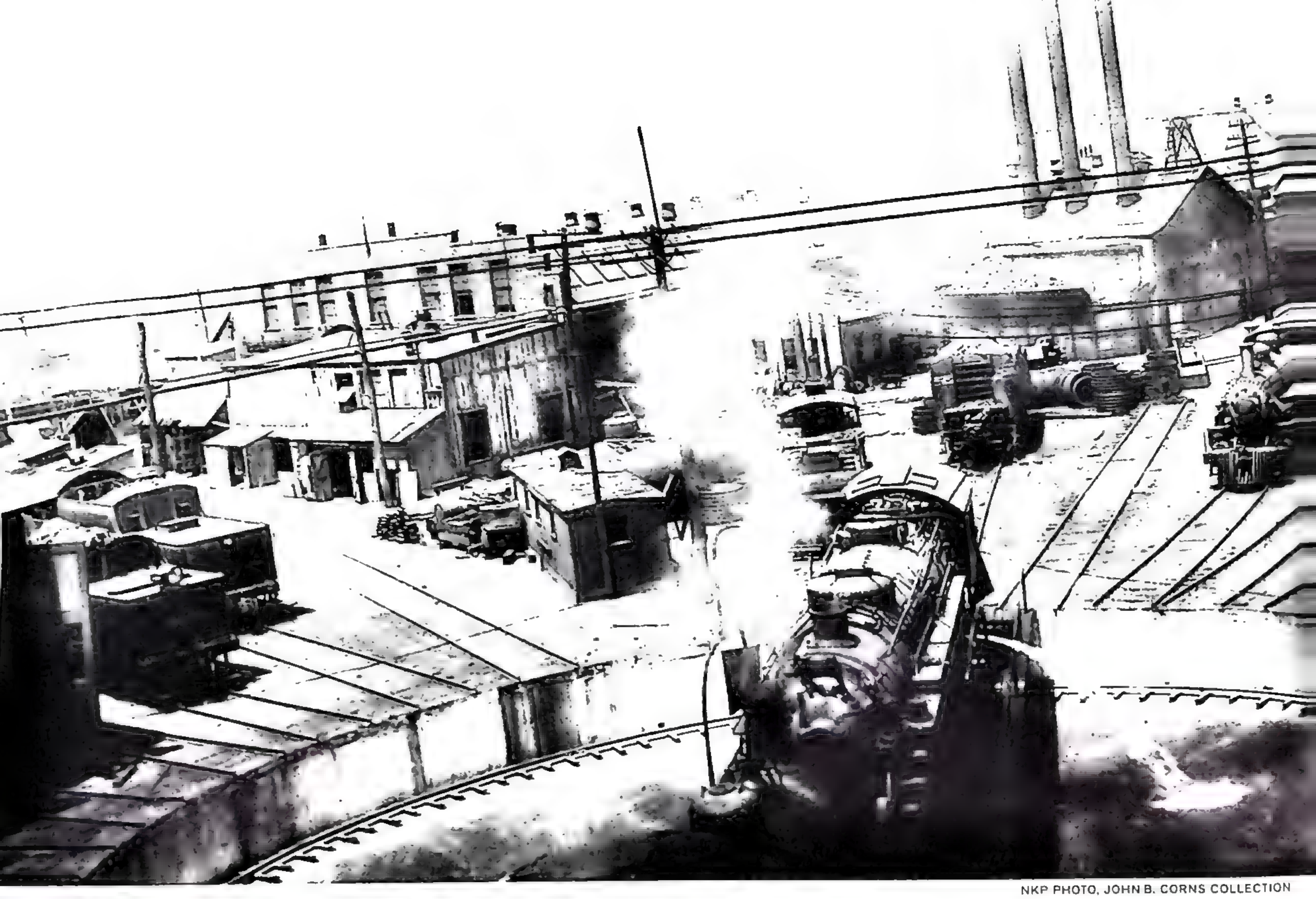
DAVIN WAS SUFFERING from the cancer that took his life a year after he left NKP in 1948, but he seemed to thrive on the task at hand. In 1947, Bellevue's ancient engine facility was replaced by a new 18-stall, brick-and-glass-block roundhouse, a 110-foot turntable, and a power house. At East 75th Street in Cleveland, NKP built a new diesel house to service the switchers based there, plus a unique, twin-tower 300-ton-capacity coal dock.

Davin also had put in motion plans to modernize the west end. On July 30, 1951, the crowded West Wayne facility at Fort Wayne, Ind., was replaced with a modern brick, five-stall enginehouse with a 110-foot turntable at a site between Fort Wayne and New Haven, logically dubbed East Wayne. At last, NKP had a thoroughly modern engine terminal befitting its Berkshires.

East Wayne was designed to expedite the servicing of eastward trains. Three through tracks ran beside or under the new 300-ton coal dock at the east end of the yard so engineers could pull up without uncoupling from their trains. (More typically, engines from Calumet or Bellevue were cut off at East Wayne to return to their home terminals; a series of crossovers expedited such moves.) East Wayne got a new yard office too, but unlike Calumet and Bellevue, East Wayne was a home terminal for crews heading east or west, so no dormitory was built.

The yard at East Wayne, built on 200 acres bought in the 1920's, originally had a dozen tracks for eastbound classification. In 1951, the yard grew to hold 1493 40-foot cars, and the main line was moved to bypass the yard along its north side to better

"HOTEL CALUMET": Nickel Plate crews had the finest in away-from-home lodging on U.S. railroads when Calumet's new dormitory opened. Among its features were a cafeteria (above) and a lounge (top left) with a television, then a relatively new curiosity. In the photo at top, the lounge is the room at the far right.



NKP PHOTO, JOHN B. CORNS COLLECTION

handle passenger trains. East Wayne was built primarily to support the 80 or so local industries, but classification was also done.

On September 30, 1951, NKP moved overnight into a similar new terminal along the east side of Lake Calumet a short ways south of Stony Island. Like East Wayne, it utterly failed the nostalgia test. Unlike East Wayne, however, Calumet was designed as an end terminal with no through tracks for complete trains running by the coal dock.

Save for the 100,000-gallon wooden water tank, everything at Calumet from a new power plant to the yard office and the highly popular crew dormitory (complete with a TV in the lounge) was as modern as one could find anywhere on the continental rail network. Calumet's 300-ton-capacity concrete coal dock was one of the last ones built in the U.S., as was the eight-stall roundhouse (six stalls for steam, two for diesel). Like the Nickel Plate's acquisition of Lima's last steam locomotive—class S-3 Berkshire 779 in December 1949—Calumet and East Wayne were testimonials to the road's continuing faith in steam.

As reported in the November 26, 1951, *Railway Age*, Berkshires at Calumet could receive their full 22 tons of coal in under 10 minutes and a complete servicing in 40 to 45 minutes. This was about half the time required at Stony Island, mainly due to getting in and out of the facilities faster.

Thanks to a boiler wash and monthly inspection at Bellevue, the Berkshires provided virtually 100 percent availability, with "road failures practically unknown," according to *Age*. Except in winter, the trade journal observed, the 700's visited the Calumet roundhouse less than one trip in 10.

THAT THE NEW ROUNDHOUSE at Calumet, like the enginehouse at East Wayne, wasn't regarded as an anachronism by frugal NKP management is evident from their business plan, which called for steam to remain on the point of fast freights into 1962. The diesel stalls were for switchers, not road units. When the facilities were built, NKP's only road diesels were a handful of EMD GP7's on the Indianapolis-Michigan City (Ind.) branch. More Geeps and some Alco RS3's dieselized the Peoria and St. Louis lines by 1955, but as far as NKP figured when Calumet and East Wayne were built, Berkshires would reign supreme on the main line for the next decade.

Such decisions were not based on sentiment. As documented by Rehor in October 1962 TRAINS, NKP in June 1948 tested an

THO PHOTOS, NKP, JOHN D. BURGER, JOHN B. CORNS COLLECTION

STONY ISLAND, THEN AND THEN: Nickel Plate's original Chicago terminal, Stony Island, was north of the new Calumet facility. In a view in 1927 or so from the roof of the old roundhouse (opposite page), we see an engine, sans tender, on the turntable being blown down and cleaned out. In the post-World War II photo above, the coach yard is seen in the distance, as are an NKP 2-8-4 and two C&O engines, 2-8-2 1176 and 0-8-0 966. The Calumet roundhouse (left) was put into service in 1951.

A-B-B-A set of Burlington F3's. A three-unit consist developed more drawbar horsepower at low speeds, but the 2-8-4's excelled in the all-important higher speed ranges, making better terminal-to-terminal time with lower fuel costs. The four-unit F3 developed more horsepower at any speed and could raise train speeds 5 to 7 mph, but higher operating costs didn't offset lower maintenance costs, and there were no savings in terminal delays. NKP's unusually high degree of steam-power utilization made the $250,000 in net annual cost of dieselizing four hotshots (eastward CB-12 and OB-2, westward BC-1 and NC-3) unattractive. A subsequent test with two F7A's on the Peoria Division also produced no orders for EMD, partly because crews found it difficult to do switching from an F-unit cab.

Unlike Stony Island, Calumet never became the site of an NKP shop, although the road's largest passenger-car servicing and repair facility was there. This continued a tradition begun at Stony Island, which in the

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TWO PHOTOS: NKP, JOHN D. BURGER; JOHN B. CORNS COLLECTION

late '40's had modernized the NKP passenger fleet by rebuilding coaches with sealed picture windows, flat ceilings, and air conditioning. NKP's few heavyweight diners were also upgraded into dining-lounge cars.

When Calumet officially opened October 1, 1951, NKP's four mainline passenger trains, Nos. 5-8, were normally worked by pairs of Alco PA1 diesels. A late train would often be handled between Calumet and La Salle Street by an H-5 Mikado to give Calumet forces time to service the PA's for the eastward run. South of the engine terminal at Calumet was a balloon track, on which the passenger trains were turned as a unit. The loop also made it easier to properly orient the increasingly popular trailers-on-flatcars for circus-style loading or unloading.

CALUMET WAS RESPONSIBLE for launching a parade of eastbound hotshots, carded as 50-series "fast freights" in the employee timetable. To sales and marketing people, the trains were better known as symbol freights CB-2 (Chicago-Buffalo), CB-12, and OB-2 (Osborn, Ind.-Buffalo; Osborn was the NKP-Indiana Harbor Belt interchange yard east of Hammond).

There were also symbol freights from Chicago to Bellevue (CN-2, which connected with Alpha Jet AJ-12 for Pittsburgh and points east and became CSN-2 by combining with SN-2 out of St. Louis for Buffalo) or to Cleveland (CC-2). Each typically got an S-2 class Berkshire (740-769), as the original S and S-1 class 2-8-4's were moved to the old Lake Erie & Western route from Bellevue to Frankfort and Peoria (and to the St. Louis Division after World War II). The S-3's (770-779) didn't have automatic train stop and so generally stayed east of Bellevue.

Calumet's daily parade began when CB-12 (which usually ran on the schedule listed for 54) left at 8:30 a.m. It braked to a stop alongside the East Wayne coal dock at 1:15 p.m. and, with a new caboose on the rear, was rolling east again 30 minutes later. CB-12 eased into busy Bellevue by 5 p.m. Central Time, and had a 7 p.m. Eastern Time departure. It arrived at Conneaut an hour before midnight and in Buffalo at 2:45 a.m. to meet critical connections with Lackawanna, Lehigh Valley, New York Central, Erie, and Pennsylvania.

OB-2, operated as train 52, left Calumet at 7:30 p.m., often as a caboose hop to a siding at Hessville, Ind., to wait for NYC and IHB meat traffic from Chicago's stockyards to be set out at Osborn in time for an 8:30

The night the music died

BRUCE R. MEYER

FINALE: Lined up behind NW2's, Nickel Plate Berkshire 762 waits for its nighttime departure east on June 19, 1958. Next morning, sister 740 would be the last 2-8-4 to leave Calumet.

In June 1958, I started a summer job with the Illinois Central in its Chicago general offices in the signal department drafting room. On the long summer days after work when the sun was out, I went out to take photos. I pretty much had freedom to go anywhere on the IC.

Just before I started the job, on May 29, several of us railfans attending the University of Illinois had driven up from Champaign to the Chicago area to take pictures. One location we hit was State Line Tower at Hammond, Ind., where we shot two eastbound Nickel Plate trains. The first had S-2 Berkshires 744 and 764 doubleheaded, and the second had 747 by itself. We were delighted to learn that NKP was still running steam into Chicago.

I don't know why I didn't try to find Nickel Plate steam again as soon as I moved to Chicago for the summer. For one thing, I wasn't sure where Calumet Yard was. On Monday, June 16, I was taking photos from the South Shore Line overpass at 130th and Torrence Avenue when Nickel Plate 2-8-4 747 went underneath, westbound with a short freight. A bit later, an NKP freight with three leased C&O GP7's followed it.

The Geeps' presence indicated that Nickel Plate steam might soon be gone, which added some urgency, and I finally found Calumet Yard and the NKP terminal, on Thursday, June 19. That turned out to be a fateful day.

Men were servicing three 2-8-4's at Calumet that evening. I first photographed the 749, sitting between the turntable and the coaling tower. I took several detail shots of it before it was put into the otherwise empty roundhouse. I also photographed the 740, which either had already been serviced or was going to be taken care of later, because it soon was moved into the roundhouse next to the 749.

Then the 762 showed up, and this S-2 became the focus of my activity for the rest the evening. It was serviced slowly over a 2- to-3-hour period, and I took photos all around it, and at the coaling tower. An employee invited me into the cab, and I spent half an hour talking and watching him at work. Almost casually, he said that these three 2-8-4's were the last to have been dispatched west from East Wayne, Ind., to Calumet. Obviously the end of Nickel Plate steam in Chicago was really at hand–I was witnessing its final night!

While I was up in 762's cab, the man continued to throw large amounts of oily waste into the firebox. Maybe this was his way of getting rid of it. Then he lit a fusee and threw it in the firebox. *KA-BOOM!* A large explosion shook the whole locomotive. I jumped a foot off the fireman's seat. For all I know, this entire show may have been for my benefit to see how I would react. The practice, while making a quick, roaring fire, could not have been good for the firebox, but since this was the end of steam, who cared?

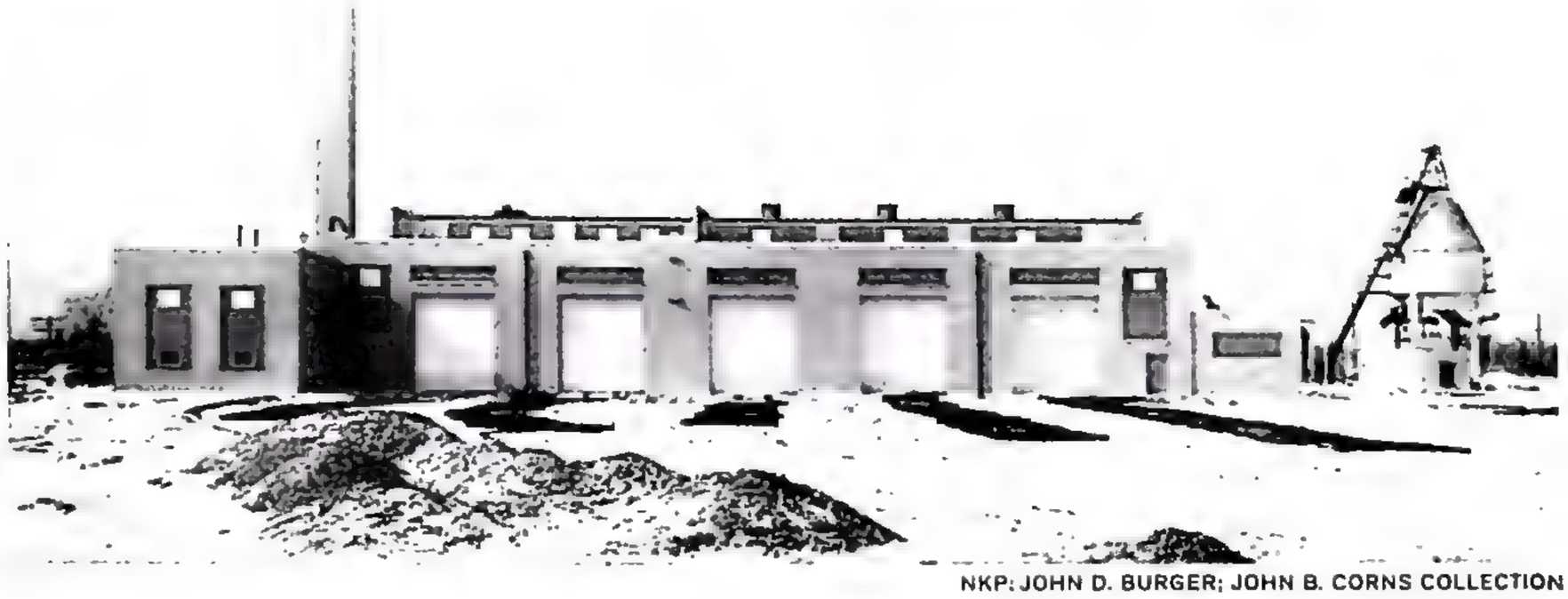
I left Calumet with mixed emotions. I was sad to see the reign of these magnificent machines end, yet happy I had been lucky enough to experience and record on film their final hours at Calumet. When I left, 762 was behind a row of diesel switchers, facing east. The Berk left during the night, followed by the 749. Finally, the 740 departed on Friday morning, dropping the curtain on Nickel Plate steam in Chicago.

I did not go back to Calumet that summer.–*Bruce R. Meyer*

ELLSWORTH CRICK, RICHARD P. YAGER COLLECTION

EASTWARD: The engineer of S-2 750 leans out to grab train orders as he crosses the Wabash at NE Cabin leaving East Wayne. Ahead are two short curves, then a 75-mile arrow-straight raceway to Arcadia, Ohio, en route to Bellevue.

SQUAREHOUSE: The modern enginehouse at East Wayne, shown here nearing completion, wasn't a roundhouse like Calumet and had just five bays.



NKP; JOHN D. BURGER; JOHN B. CORNS COLLECTION

departure. It arrived in East Wayne just after midnight. It was not unusual for NKP to run an Advance OB-2 and up to three sections of the regular OB-2.

OB-2 was scheduled out of East Wayne 30 minutes after arrival and halted at the long icing platform in Bellevue at 3:55 a.m. After the reefers were iced, cars for the Wheeling District's AJ-2 set out, and the engine changed, OB-2 was racing east toward Conneaut an hour later. It arrived at 11 a.m., left 15 minutes later, and tied up in Buffalo's tiny Tifft Yard at 3:30 p.m.

CB-2 (train 54) got out of Calumet a half hour before midnight and arrived in East Wayne at 5:30 a.m., leaving 45 minutes later. At Continental, Ohio, it picked up cars from the Toledo Division (old Clover Leaf). At Bellevue, cars for AJ-4 came off and the engine was changed. It was due out at 1:15 p.m., 75 minutes after arrival, into Conneaut at 6 p.m. and into Buffalo at 10:30 p.m., just 22 hours since its run began in Illinois.

And so it went, day after day, year after year, until 1958. By June 1, only 24 steam locomotives were active on the Chicago Division. On June 13, 25 GP7's leased from C&O arrived, and five days later, the last steam-powered westbound left Bellevue for East Wayne and Calumet behind S-2 740. On June 20, the 740 led No. 32 out of Calumet for East Wayne, arriving just before midnight. The S-2 went east the next day to Bellevue, dropping the curtain on West End steam after 77 years. To a sister S-2, 746, would go the honor of leading the last mainline freight on the system when she ran from Bellevue to Conneaut on July 2, 1958.

What the diesel salesman failed to do in the 1940's—banish steam from the Nickel Plate—the spiraling cost of maintaining the locomotives and the recession of 1957-58 teamed up to accomplish. Never again would a 700 have the opportunity to show shippers and competitors what it could do in a fair fight. As far as steam was concerned, the Berkshire launching pad at Calumet, which had debuted with such promise less than a decade before, was eternally cold. ■

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N&W's MOUNTAIN MACHINES

The right tool for the job: Norfolk & Western's compound 2-8-8-2s were compact, efficient, and phenomenally powerful

BY ED KING

Raw power: A Y-6 pusher nearly fills the rear door of the caboose of train freight 86 climbing Allegheny Mountain in 1954.

WEST TO EAST, Y-2 TO Y-6

In Cincinnati (left), an unidentified Y-2a hammers east past a waiting B&O Mikado in April '43; the 2-8-8-2 has footboards for yard and transfer work. At Davy, W.Va. (below), Y-4 2087 wheels fast freight 99 downgrade beneath Elkhorn Mountain catenary in 1930. Tiny Pepper, Va. (right), is the setting for a company photo of Y-6b 2196—one of the last Y's built—rolling east with Tidewater-bound coal.

STEPHEN A. LIEBER

CLASSIC TRAINS COLLECTION

in the front section, which was to be kept full of water at all times; this section acted as a feedwater heater. The separable boiler was never really satisfactory, and was not used again on the N&W.

N&W already had an active test department, and borrowed Westinghouse's dynamometer car to evaluate the X-1 and Y-1. The performance of the X-1 0-8-8-0 was significantly better than the Y-1's, but its lack of the riding stability provided by leading and trailing wheels prevented the duplication of its wheel arrangement on the N&W.

Meanwhile, N&W's neighbor and fellow Pocahontas coal-hauler Chesapeake & Ohio had received a 2-6-6-2 in 1910 that was comparable in weight and power to the X-1 and Y-1. Impressed, C&O ordered 24 more that incorporated the new Schmidt superheater. N&W borrowed one of these and tested it against the Y-1; C&O's 2-6-6-2 ran rings around the 2-8-8-2. N&W was impressed, too, and began buying a fleet of superheated 2-6-6-2's in 1912 that by 1918 numbered 190 locomotives in classes Z-1 and Z-1a. Their tractive effort was 86,250 pounds in simple, and 71,875 compound.

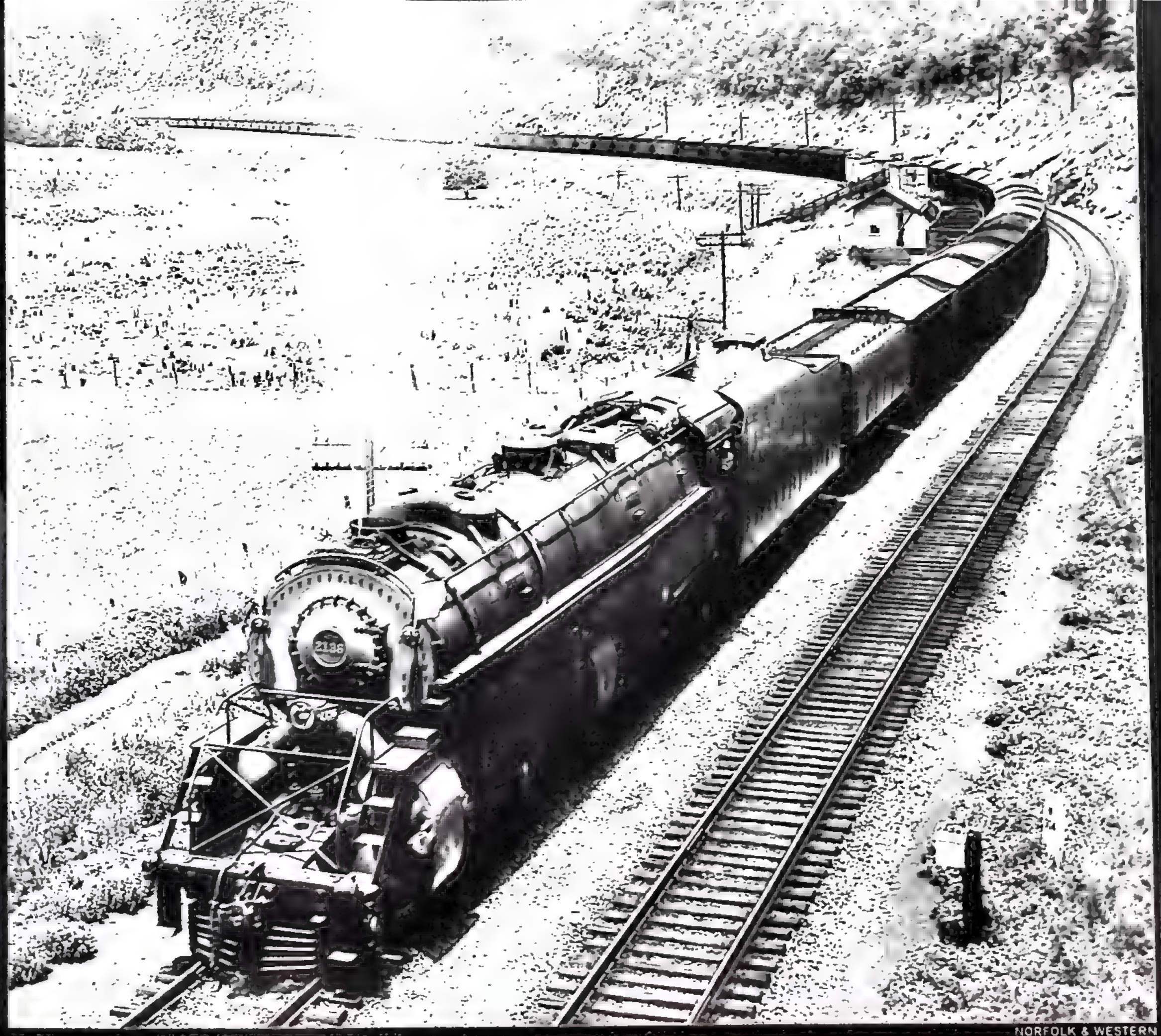
The eastward 2 percent grade and tight 3300-foot tunnel on Elkhorn Mountain west of Bluefield were challenges that the 2-6-6-2's couldn't master, however. N&W electrified that portion of the railroad in 1914, a move that relieved a bad situation—not only was the single-track tunnel a traffic bottleneck, but it was dangerous for the crews.

Elsewhere, N&W stuck with steam, but the 2-6-6-2, as good as it was, wasn't powerful enough to satisfy the demands of the operating department. A bigger locomotive was needed—sending boys out to do men's work was not the answer.

ROANOKE'S OWN MALLET

The new locomotive was to be used systemwide, but several areas of sharp curvature in rock cuts and in tunnels necessitated the most compact design possible. The overhang of the boiler at the front was to be kept to a minimum, as was the overhang at the rear.

The result was Y-2 2-8-8-2 No. 1700, completed by N&W's Roanoke Shop in March 1918. The restrictive clearances had limited the diameter of the low-pressure cylinders to 39 inches, so the Y-2 used 24½-inch high-pressure cylinders (the 2½ to 1 ratio of



low-pressure to high-pressure piston area was the same as on the X-1 and Y-1, and was seen to be a beneficial proportion) with a 32-inch stroke turning N&W's standard (at the time) 56-inch driving wheels. A 96-square-foot grate area nourished a boiler with 7850 square feet of heating surface, insuring a free-steaming locomotive. Because of the "small" cylinders (Virginian Railway, for example, had 2-8-8-2's with 44-inch low-pressure cylinders), the Y-2 used a boiler pressure of 230 psi, quite high for 1918.

Like the earlier Mallets, the Y-2 could be started in simple operation for more power, and then by means of an intercepting valve changed over to compound when the train got moving. A reducing valve was necessary for use in simple operation; full boiler pressure in the big low-pressure cylinders would have resulted in unsatisfactory slipperiness. Tractive effort of the Y-2 was 135,600 pounds in simple operation, 104,300 pounds in compound. Both these figures were revised downward after testing with N&W's own dynamometer car, which arrived in 1919.

But the Y-2 was just as powerful as any of those big-cylindered, lower-boiler-pressure Mallets, and the use of higher pressure in smaller cylinders promised both greater speed and economy. Not only did the higher boiler pressure make the rear engine more powerful, but the exhaust gave the low-pressure engine steam of significantly higher pressure and heat content to work with. Subsequent modifications saw the boiler pressure raised to 240 psi, high-pressure cylinders modified for a 25-inch bore, and thicker tires that resulted in a driving-wheel diameter of 57 inches. These changes resulted in reclassification to Y-2a. Baldwin and Roanoke turned out a total of 31 Y-2's and Y-2a's.

The requirements for short overhang at the rear resulted in the Baldwin-style trailing truck appearing as though it was half under the rear of the firebox and the rest under the cab. The trailer's purpose was not so much to carry weight as to provide guidance for back-up movements.

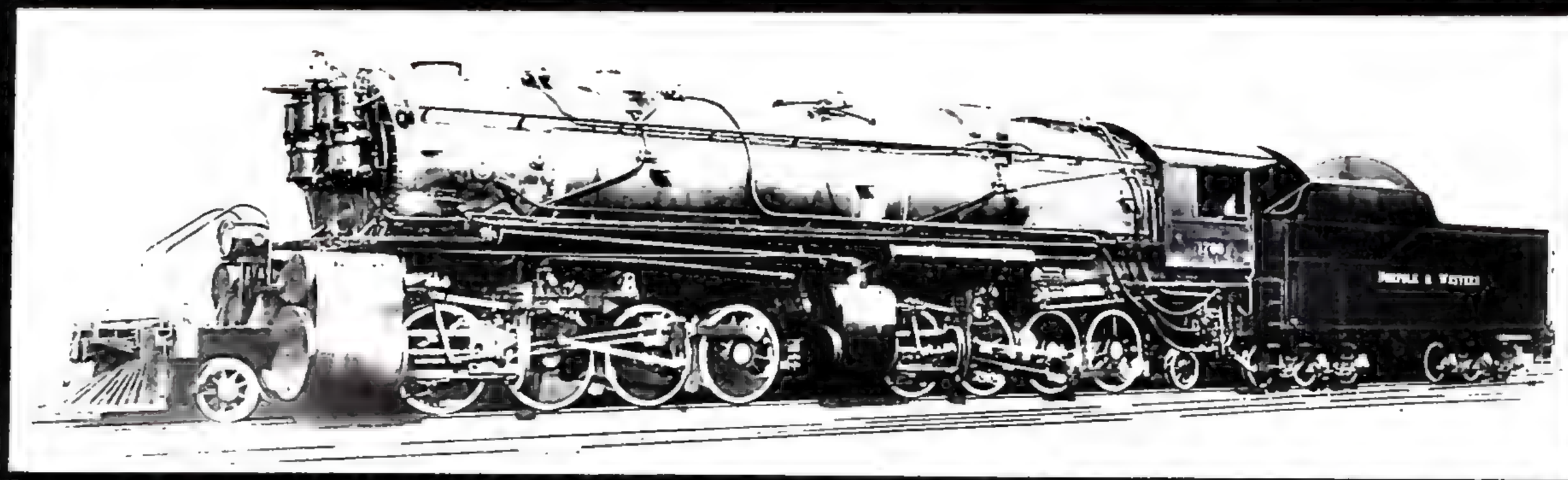
World War I saw the advent of the United States Railway Administration, which operated the railroads during the conflict. A mechanical committee was formed to provide plans for a number of standard locomotives, including 2-6-6-2 and 2-8-8-2 Mallets. N&W's John Pilcher was a delegate to the USRA design committee, and he

SAMPLE, AND SUCCESS

Y-1: No. 999 was from N&W's first group of five 2-8-8-2's, built by Baldwin in 1910 when the road was sampling 16-drivered power. Poor performers, they were retired in 1924.

Y-2: More successful was Y-2 1700 of 1918, the first of N&W's extraordinary family of home-grown 2-8-8-2's. A refined version (class Y-2a) was the template for 106 USRA locomotives, half of which went to N&W itself as Y-3's 2000-2049.

J. J. ATWATER



BALDWIN LOCOMOTIVE WORKS, H. L. BROADBELT COLLECTION

showed up with the blueprints for the Y-2a under his arm, which the USRA used as the basis for its heavy Mallet.

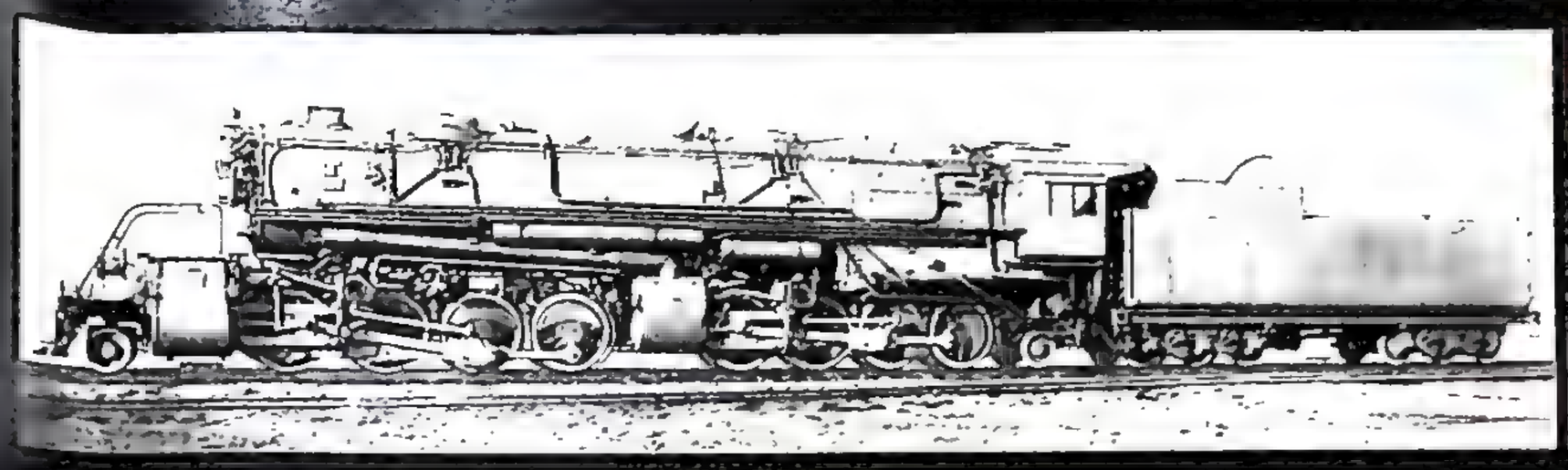
USRA's 2-8-8-2 utilized the Y-2a's cylinder, driving-wheel, and firebox dimensions, as well as its boiler pressure and trailer truck located half under the cab. Like the Y-2a, the USRA 2-8-8-2 had its air pumps mounted on the smokebox front. The USRA machine weighed 531,000 pounds and developed 121,600 pounds of tractive effort in simple operation and 101,300 pounds compound.

Still needing power, N&W bought 50 USRA 2-8-8-2's in 1919. They were classed Y-3, numbered in the 2000 series, and equipped with the standard USRA 16-ton, 12,000-gallon tenders. Thirty class Y-3a 2-8-8-2's followed in 1923; these differed from the Y-3's only in the use of a boiler inspection hatch just forward of the steam dome on the left-hand side, and the use of an N&W-designed tender.

Ten more 2-8-8-2's arrived in 1927. These Y-3b's (later reclassed Y-4) were the first N&W Mallets to be built with Worthington BL feedwater heaters, which were hung on the left side of the boiler (to balance the BL's weight, the air pumps were moved to the right side). The Y-3b's also incorporated a slant-front "sport-model" cab intended to facilitate staybolt inspections; their engine weight was 567,000 pounds. These were the last new locomotives N&W bought from a commercial builder.

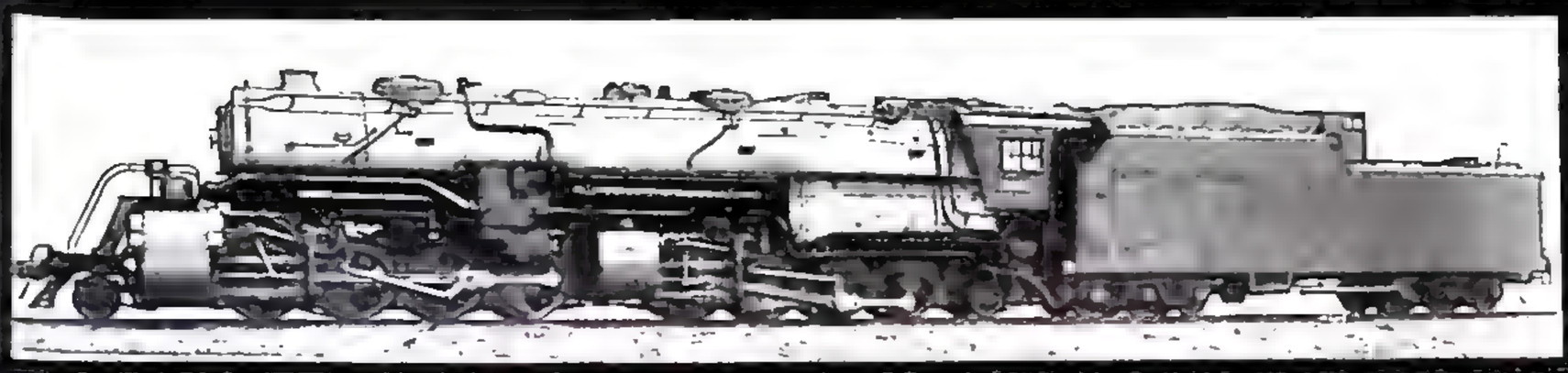
The USRA-design 2-8-8-2 was considered a very fine locomotive, but many felt it was capable of more power and speed. Increases in boiler pressure were indicated, and all the 1700- and 2000-series Y's were raised to 270 psi. This boosted their tractive effort to 136,985 pounds in simple operation, 114,154 pounds in compound. Simple operation was effective up to 4 mph.

Testing identified points in the steam path from the boiler to the smokestack where excessive restrictions or areas of back pressure existed. In 1928, Y-3 2049 was modified with a pair of low-pressure cylinders which were joined by a large arched exhaust pipe (called a bridgepipe) from which a large-diameter exhaust pipe led to the bottom of the smokebox and the exhaust nozzle. The bridgepipe was so successful in reducing back pressure on the low-pressure cylinders that every new Y-class locomotive after the Y-4 would be built with it.

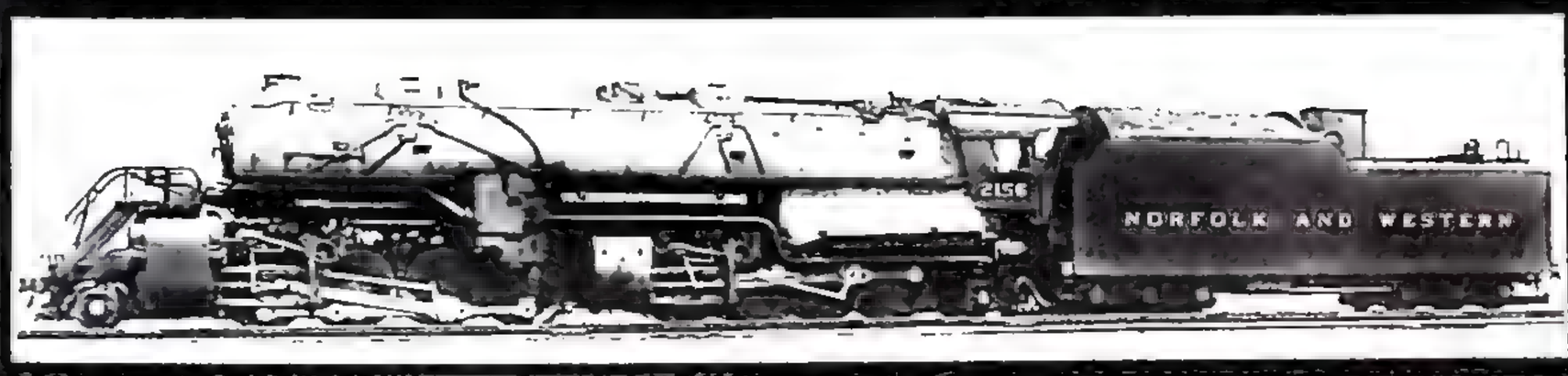


HEAVY-HITTER HIT PARADE

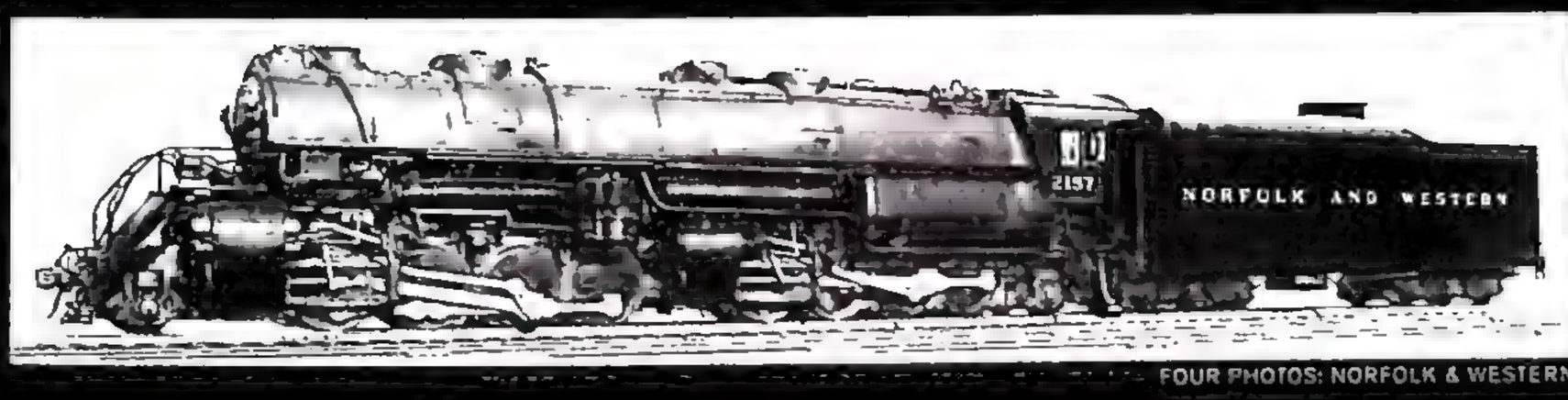
Y-3a: Nos. 2050-2079 were the post-USRA version of the Y-3. No. 2063 shows the two most obvious changes: larger N&W-style tender, and boiler inspection hatch between the front sandbox and steam dome.



Y-5: The Y-3b (later called Y-4) of 1927 introduced the modern Y look: air pumps moved from smokebox front to right side, BL feedwater heater on left side, slant-front cab. No. 2092 is 1 of 20 similar Y-5's; she was destroyed in a 1937 wreck.



Y-6a: Like the Y-6's of 1936-40, war baby Y-6a 2156 has cast engine-bed frames, roller bearings on all locomotive axles, and a slightly angled smokestack. Plain bearings on the tender were among the minor differences from the Y-6.



Y-6b: The 2197, fourth-to-last 2-8-8-2 built, shows two hallmarks of this last word in N&W steam: Worthington feedwater heater ahead of the stack, and big "streamlined" tender. Few could touch their 166,000 lbs. of tractive effort.

FOUR PHOTOS: NORFOLK & WESTERN

SIMPLES AND SUPER-POWER

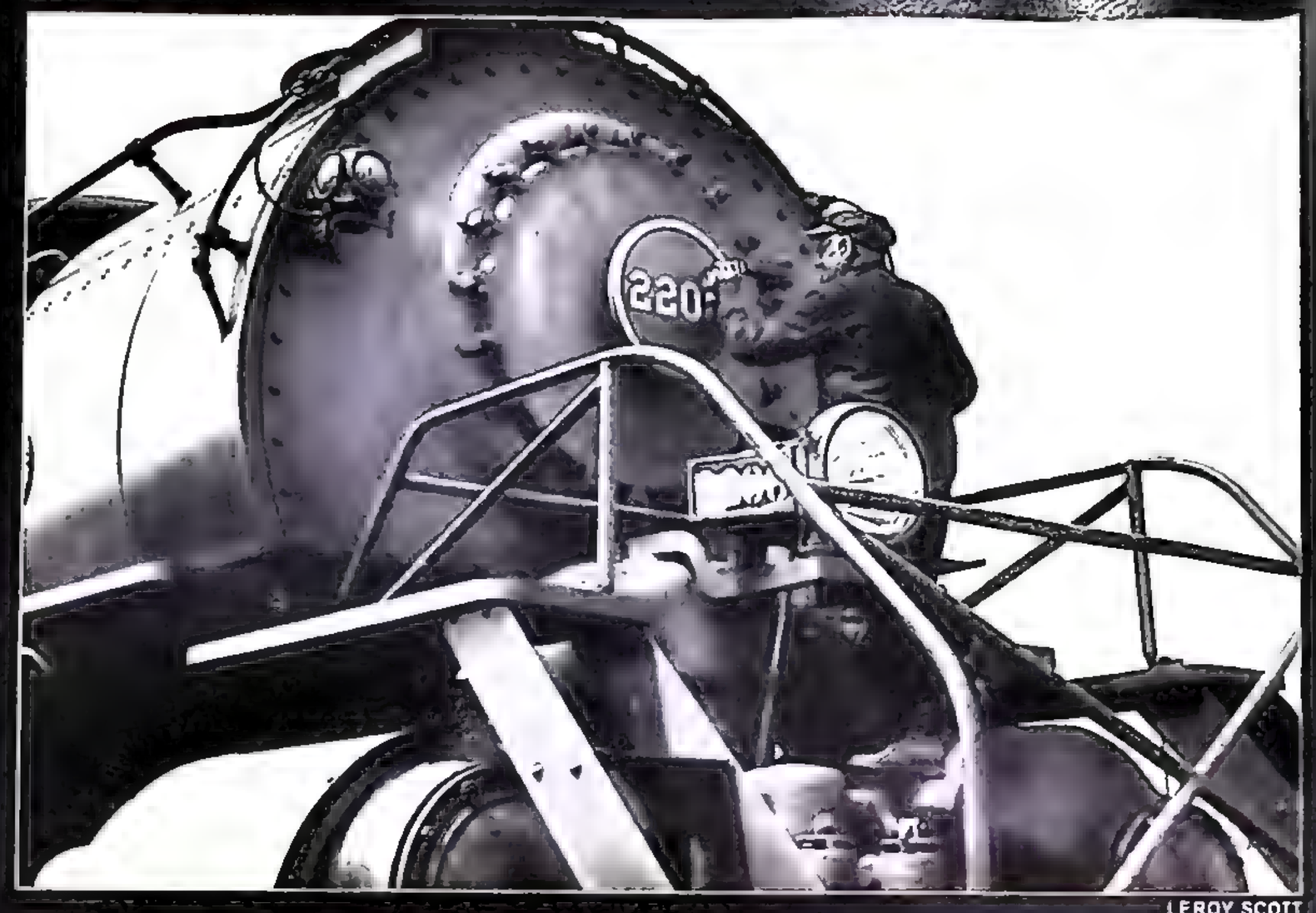
By this time, N&W was poised to take the development of its heavy mountain slugger to truly outstanding levels. The road's careful, fruitful nurturing of the Mallet design throughout the 1920's stood in contrast to other trends in motive-power design in that decade. Competition between the commercial locomotive manufacturers was heating up, and each of the three was trying to develop sales tools to put itself in the forefront of the market. Lima was pushing its "Super-Power" concept; Alco was trumpeting the virtues of three-cylinder drive; Baldwin was involved with simple articulated locomotives and exploitation of the export market.

The simple articulated had been tried first by the Pennsylvania, which produced a 2-8-8-2 in 1911. PRR followed this less-than-successful machine with a massive 2-8-8-0 in 1919 whose 147,000 pounds of starting tractive effort was said to be too much for the equipment of the day.

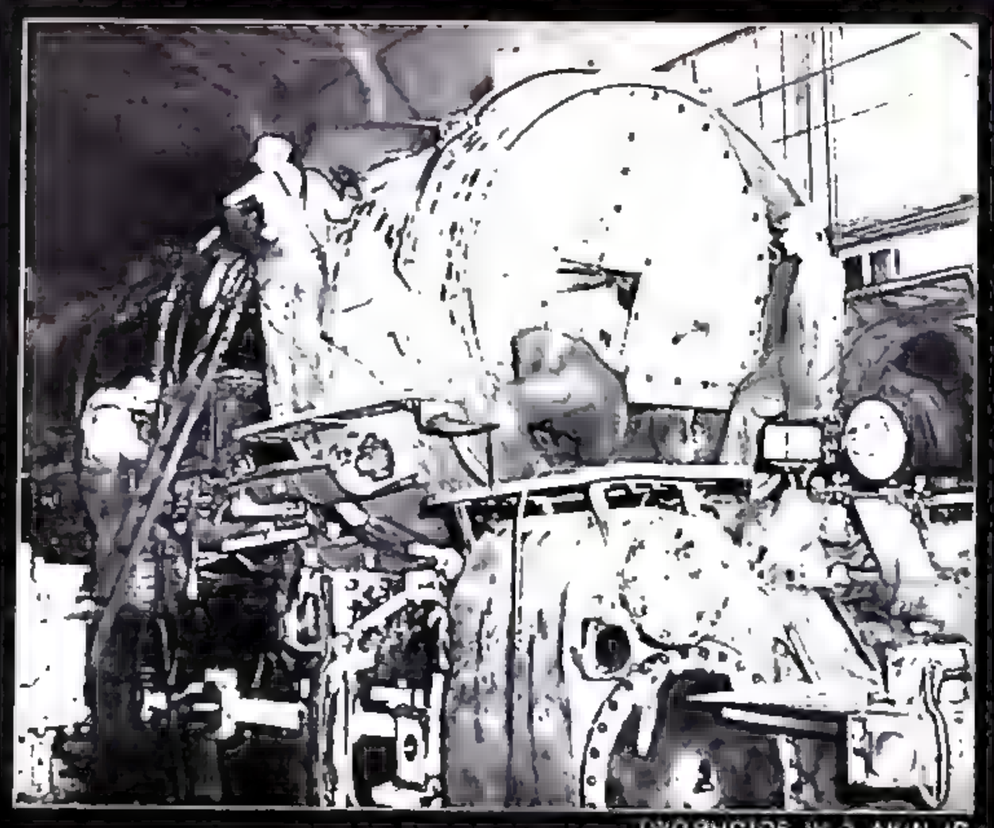
The first fleet application of the simple articulated concept came in 1924 when Alco built 25 class H-7 2-8-8-2's for Chesapeake & Ohio. Twenty more followed from Baldwin in 1926, classed as H-7a. The H-7's weighed 565,000 pounds; the H-7a's, 572,300 pounds.

Although possessed of a ferocious appearance, the H-7's actual capabilities were modest. With their original boiler pressure of 205 psi, their starting tractive effort was only 103,500 pounds (a later change to 215 psi yielded 108,550 pounds of tractive effort). The result: they were outperformed and replaced on Russell (Ky.)-Toledo (Ohio) coal trains by C&O's very fine 2-10-4's of 1930, whose booster-augmented tractive effort equaled that of the H-7.

In the late 1920's and early '30's, several western railroads were developing fleets of 16-drivered simple articulateds, which the builders touted as being faster than compounds. These were very large machines that far outclassed the C&O H-7; usually they had 63-inch drivers and 26- to 28-inch cylinder diameters with boilers to match. Fleets of 2-8-8-2's were acquired by Western Pacific (engine weight 663,100 pounds, tractive effort 137,000 pounds), Rio Grande (engine weight 639,000, tractive effort 132,000), and Great Northern (engine weight 630,750, tractive effort 146,000). Northern Pacific got the biggest—the world's largest locomo-



LEROY SCOTT



TWO PHOTOS, W. A. AKIN JR.

MEN AND MALLETS

In a display of the pride N&W men took in their locomotives (above), an employee of long seniority wipes down the numberplate of No. 2200 in May 1952, one month after this very last Y-6b was built. Shopmen swarm over Y-4 2081 (left), in for work at Roanoke in 1954. At Christiansburg, Va. (far left), the rear brakeman of hotshot 86 uncouples Y-6 2152, which has helped the train up the 1 percent grade from Walton.

tives of the day, the first 2-8-8-4's weighed 717,000 pounds and developed 140,000 pounds of tractive effort. Southern Pacific had what amounted to a turned-around 2-8-8-4 in the form of its famous cab-forward 4-8-8-2's (1927 version: engine weight 615,000, tractive effort 113,000).

N&W STAYS THE COURSE

But N&W was convinced that the Mallet had not been developed to the extent possible, and believed that, for long uphill runs with heavy tonnage, compounding was still the most efficient answer. Accordingly, in 1930-32 Roanoke Shops turned out 20 class Y-4a (later reclassed Y-5) 2-8-8-2's following the Y-3/Y-3a/Y-4 pattern. The fireboxes were widened 10 inches to yield 106.2 square feet of grate area, and boiler pressure was raised to 300 psi; this gave them a tractive effort in compound operation of 126,838 pounds, in simple 152,206 pounds. They weighed 582,900 pounds.

The Y-4a/Y-5 continued the use of N&W's favored Baker valve gear, with virtually all parts being interchangeable between the front and rear engines. They did not incorporate recent innovations such as roller bearings or one-piece cast frames with integral cylinders, and it was soon found that the old fabricated frames with separate cylinders could not cope with the stresses of the more powerful machinery.

In the Y-5, the N&W finally had the potent mountain mauler it so badly needed. The 25- and 39-inch cylinders with the bridgepipe low-pressure exhaust system, the free-steaming boiler with the 106 square-foot grate, and the 300 psi boiler pressure would prove satisfactory elements for N&W's "men for the mountains" for the next quarter-century. Other modifications would follow—what might be referred to as "fine tuning"—but those cylinder dimensions coupled with the high boiler pressure ensured that the locomotive could produce more work for its weight than anything else on wheels propelled by steam.

The Great Depression kept things quiet on the N&W, as on other roads, until 1936, when the first class A 2-6-6-4 simple articulateds rolled out. Not intended to be mountain sluggers, they would prove to be the answer to the railway's prayers for a flatland fast-freight hauler and a heavy passenger engine for the mountains.

Also in 1936 came the first of the great Y-6 2-8-8-2's, No. 2120. Like the A, the Y-6 had cast engine-bed frames with integral cylinders and roller

GIANTS COMPARED: N&W 2-8-8-2's, C&O Allegheny, UP Big Boy

RAILROAD	N&W	USRA (N&W)	USRA (N&W)	N&W	C&O	UP
WHEEL ARRANGEMENT	2-8-8-2	2-8-8-2	2-8-8-2	2-8-8-2	2-6-6-6	4-8-8-4
CLASS	Y-2a	Y-3	Y-3	Y-5/6/6a/6b	H-8	4884-1, -2
BUILDER	N&W, Baldwin	American	American	N&W	Lima	American
YEARS BUILT	1918-24	1919	1919	1930-52	1941-48	1941-44
ROAD NUMBERS	1700-1731	2000-2049	2000-2049	2101-2200	1600-1659	4000-4024
BOILER PRESSURE (PSI)	240	240	270	300	260	300
HIGH-PRESSURE CYLS. (IN.)	25x32	25x32	25x32	25x32	22½x33	23¾x32
LOW-PRESSURE CYLS. (IN.)	39x32	39x32	39x32	39x32	-	-
DRIVER DIA. (IN.)	56	57	58	58	67	68
GRATE AREA (SQ.FT.)	96	96.6	96.6	106.2	135	150
BOILER, MAX. OUTSIDE DIA. (IN.)	not avail.	104⅞	104⅞	104¼	109	106⅝
TOTAL HEATING SURFACE	7859	7160	7335	7422	10,426	8155
WHEELBASE, ENG. & TNDR.	97 ft. 3 in. (1)	94 ft. 6 in. (2)	102 ft. 1 in. (3)	103 ft. 9 in.	112 ft. 11 in.	117 ft. 7 in.
WEIGHT ON DRIVERS (LBS.)	472,000	478,000	485,200	548,500	503,010 (4)	540,000 (5)
LOCOMOTIVE WEIGHT (LBS.)	526,000	531,000	539,000	611,520	751,830 (4)	762,000 (5)
WT. ON DRIVERS/LOCO. WT. (%)	89.3	90.0	90.0	89.7	67.0 (6)	70.8 (6)
TRACTIVE EFFORT, SIMPLE (LBS.)	(7)	121,600	136,985	166,000	110,200	135,375
TRACTIVE EFFORT, COMPOUND	(7)	101,300	114,154	132,000	-	-
DRAWBAR H.P. AT 25 MPH	not avail.	not avail.	not avail.	5600	5600	5600
DRAWBAR H.P., MAXIMUM	not avail.	3200	not avail.	5600	7498	6300
MAX. DRAWBAR H.P. SPEED	not avail.	15 mph	not avail.	25 mph	42 mph	41 mph

NOTES: (1) With 16,000-gal. tender. (2) With 12,000-gal. USRA tender. (3) With 18,000-gal. tender. (4) Figures are for C&O Nos. 1645-1659; wt. on drivers for earlier H-8's ranged up to 507,000, loco. wt. ranged up to 778,000. (5) Figures are for UP Nos. 4000-4019; wt. on drivers for UP 4020-4024 is 545,200, loco. wt. 772,250; (6) Based on figures for lightest members of class. (7) N&W documents list more than one figure; tonnage ratings same as Y-3.

bearings on all axles. The Y-6 also differed from the Y-5 in having outboard bearing leading and trailing trucks. The roller bearings insured greater availability and the cast frames could easily handle the stress of the high power output. Through 1940, N&W built 35 of these modern compounds. An oddity of the Y-6 and those classes following was an 8-degree forward slant of the exhaust nozzle and smokestack. This was necessary to allow the nozzle to remain in its normal location while allowing room at the top in front of the flue sheet for an American Multiple front-end throttle.

During 1940-41, to increase availability and cut down on repairs, N&W equipped its Y-5 fleet with cast bed frames and roller bearings on all axles, including the leading and trailing trucks, which retained their inboard-bearing design. This gave the road 19 more locomotives of Y-6 quality (1 of the original 20 Y-5's having been destroyed in a wreck in 1937). Y-5's 2101-2109 retained their original numbers; the 2090, 2091, and 2093-2100 were renumbered 2110-2119. This kept all the 2-8-8-2's with 300 psi boiler pressure, roller bearings, and cast frames in the 2100 series.

Here was a locomotive whose horsepower curve peaked at 5000 at 25 mph (an ideal speed for N&W's curves, grades, and tonnage), was superbly counterbalanced so that speeds of 45-50 mph could be attained without damage to locomotive or track, and could produce over 152,000 pounds of starting tractive effort. All this was wrapped up in a package that would easily fit on a 115-foot turntable and weighed just 291 tons. The 25 mph peak of the horsepower curve meant that N&W would get the benefit of every horsepower the locomotive was capable of producing, instead of working off the front slope of a horsepower curve that peaked at a higher speed that the locomotive would seldom attain under full-throttle operation.

THE ULTIMATE 2-8-8-2: Y-6b

World War II put great demands on every railroad, N&W included. Roanoke responded by producing 16 more 2-8-8-2's in 1942. These Y-6a's were just like the Y-6's except for a different design of driving wheel. Tire thickness for all classes was increased, resulting in a driver diameter of 58 inches.

Neither Allegheny nor Big Boy approached the Y's high percentage of weight on drivers vs. total weight. All produced equal horsepower at 25 mph—a more useful speed for peak power than faster gaits.

N&W's search for even greater efficiency never ended. Testing showed that at the front end of the boiler the 24-foot flues were contributing little to the steaming of the locomotive, so it was decided to shorten them by 4 feet, extending the combustion chamber of the firebox by that amount. The result was an even more free-steaming boiler, able to operate at higher outputs with a clear stack.

Tests also showed there was too much back pressure at the exhaust nozzle, so a larger annular-ported nozzle was provided with an even larger smokestack.

The need to replace the aging Y-2a's, plus a massive line relocation on the Elkhorn grade, prompted N&W's final round of 2-8-8-2 construction. The re-

A 2-8-8-2 dives into the new Elkhorn Tunnel in 1951. Electrics ruled this grade for 36 years, until a line change cut the hill to "only" 1.4 percent, well within the capabilities of N&W's modern steam power.

location involved eliminating the steepest part of the grade, replacing the single-track tunnel with a double-track bore, and retiring the 56-mile electrification. The withdrawal of the old electric locomotives created the need for additional power, which arrived between 1948 and '52 in the form of 30 Y-6b 2-8-8-2's. At a time when other roads were replacing steam and electric power with diesels, N&W was replacing obsolete electrics with state-of-the-art steam locomotives. Further indication of N&W's unique faith in steam may be found in the fact that the final Y-6b, No. 2200, was the very last steam locomotive built for road service in the U.S.

The Y-6b's differed from earlier Y's in several ways, the most important of which was the use of the Worthington 6-SA feedwater heater instead of the BL. With the cold water pump under the cab, the hot water pump under the chin of the smokebox (later relocated to the left side of the smokebox under the running board) and the feedwater heater ahead of the smokestack, one air pump could now be located on each side of the locomotive. Another, less obvious change was the use of roller bearings on the back ends of the eccentric rods.

Even as the 30 Y-6b's were under construction, tests were being run to determine if even more power could be developed; it was felt that the low-pressure engine was capable of adding more to the drawbar pull, particularly at low speeds. Accordingly, an extensive redesign of the intercepting and reducing valves was done and a new arrangement installed with these valves located above the right high-pressure cylinder. In order to accommodate the additional power, approximately 29,000 pounds of lead was added to the low-pressure engine's frame, increasing locomotive weight to 611,530 pounds. Tractive effort in compound operation was now 132,000 pounds, simple 166,000 pounds, and horsepower peaked at 5600 at 25 mph. Simple operation was now effective up to 10 mph.

An additional item N&W men called a "booster valve" was added. Not an auxiliary engine, N&W's booster consisted of an arrangement which allowed the engineer to admit a measured amount of boiler steam to the low-pressure receiver in compound operation; this raised the pressure—and just as importantly, the temperature—of steam going to the low-pressure cylinders. Thus, if the going was getting tough at a speed too high for simple operation, the booster valve could be employed for extra power.

These improvements were retrofitted to all the older 2100's. This resulted in a tonnage rating increase to 3600 tons on the realigned 1.4 percent Elkhorn grade and 5150 tons on the 1 percent Alleghany Mountain climb. Bluefield-Roanoke coal trains were now dispatched with 10,300 tons, and a Y-5 or Y-6 with a like pusher would still go up the mountain at 15 mph.

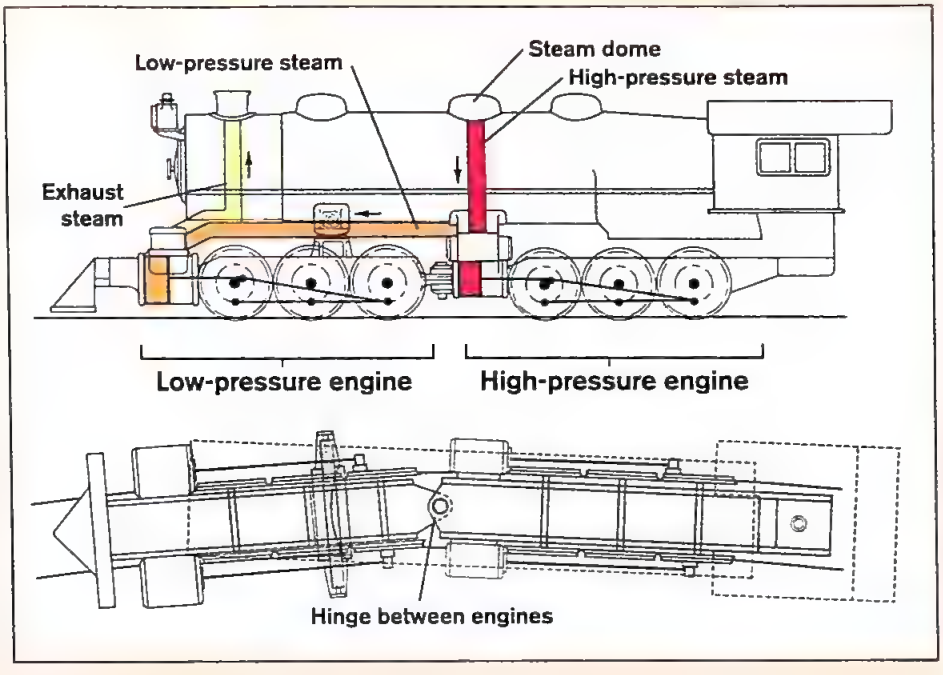
On the Bluefield-Roanoke run, these locomotives were in their element. After reaching the bottom of the mountain at Glen Lyn, the climb up the New River valley to Walton was negotiated at 31-32 mph; a steeper hump (0.32 percent) east of Pearisburg would drop speed back to about 26-27 mph, after which the Y would pick its 10,300 tons right back up to running speed. This was an excellent example of tailoring a locomotive's horsepower curve to the service requirements—working along at a speed just higher than the peak of the curve. There was nothing wasted here—no 6000 or 7000 h.p. locomotive trying to lug tonnage at a speed far lower than its maximum horsepower output.

Standard procedure on coal trains between Williamson, W.Va., and Bluefield called for handling trains of 7000-7500 tons as far east as Farm, W.Va., which was the foot of the 1.4 percent Elkhorn climb. Averaging 25 mph for this 62.9 miles, gradually uphill up the Tug River, the Y-6 would burn about 13.5 tons of coal and con-

From the Alps to the Alleghenies

On June 18, 1884, the eminent European engineer Anatole Mallet (mal-LAY) (1837-1919) took out French Patent No. 162,876 for the system of articulated compound locomotives which made his name famous in railroading the world over.

Mallet intended his locomotive to be more of a practical system of compounding than to be a means of articulating a large locomotive to enable it to negotiate sharp curves. Compounding—the use of steam twice before exhausting it to the atmosphere—had been tried before in several types of more or less conventional locomotives, but without a great deal of success. Mallet's patent covered both the system of articulation and the compounding.



The Mallet locomotive consisted of two engines under one boiler; the rear engine was rigidly attached to the boiler, while the front engine was hinged to the rear one and swiveled underneath the front of the boiler. Various methods were used to transmit the weight of the front end of the boiler to the front engine; a sliding flat bearing with centering devices became the most popular.

The rear engine took steam directly from the throttle, as on a conventional locomotive. After this steam was expanded in the high-pressure (rear) cylinders, it was exhausted into a receiver and passed through jointed piping to the low-pressure (front) cylinders, which exhausted through jointed piping to the bottom of the smokebox and thus through the exhaust nozzle to the stack. To compensate for the lower steam pressure of the exhaust steam from the rear cylinders, the front cylinders were of considerably larger diameter.

Simple articulateds used high-pressure steam in all four cylinders. They were generally capable of higher speeds than Mallets.

The Mallet did, indeed, prove to be the most effective application of compounding to a railroad locomotive ever conceived, and effectively placed the power of two locomotives under the control of one crew. This was its greatest selling point.

The Mallet was first built in the U.S. by Alco, which constructed an 0-6-6-0 for the Baltimore & Ohio in 1904. Mallet use snowballed; they appeared in North America in 2-4-4-2, 0-6-6-0, 2-6-6-0, 2-6-8-0, 2-6-6-2, 0-8-8-0, 2-8-8-0, 2-8-8-2, 2-10-10-2, 4-4-6-2 and 4-6-6-2 wheel arrangements, and were expanded into the ill-fated Triplex system with a third engine under the tender—Erie's 2-8-8-8-2's and the Virginian's 2-8-8-8-4. The last U.S. Mallet was N&W 2200, built in April 1952.

Mallet lived long enough to know of the first simple articulated locomotive built for the Pennsylvania in 1911; he is said to have viewed this as a terrible corruption of his idea.—*Ed King*

sume an average of 21,500 gallons of water. Tonnage would be reduced to about 3600 at Farm. From there to Bluefield, 35.5 miles with a ruling grade of 1.4 percent, the locomotive would average about 18.5 mph, burn about 8.25 tons of coal, and use about 13,500 gallons of water. (There was no need to stop for water—thanks to the use of auxiliary tenders, the 2-8-8-2's left Williamson with more than 40,000 gallons on board.)

THE CASE FOR THE COMPOUND

This was the mountain locomotive that would enable Norfolk & Western to maintain its leadership in the industry in gross ton-miles per train-hour and gross income carried over to net until rising fuel and labor costs mandated dieselization by 1960. This was accomplished by a machine with a boiler about the same size as N&W's class J 4-8-4, and whose weight on drivers was less than 70,000 pounds per axle. Compounding—a concept dismissed by the rail industry in the 1920's as being incompatible with the necessity for speed—made such performances possible.

One wonders why the commercial locomotive builders were so quick to condemn the compound to locomotive perdition. Their decision to do so must have resulted in a tremendous inflation of fuel and water costs to their customers, especially those in the West where fuel and water often had to be transported long distances to servicing points.

A fundamental error made by locomotive historians has been to attribute to the commercial builders motives that didn't actually exist. They were not kindly, benevolent souls intent only on providing their customers the most efficient and profitable power that could be had. Rather, they were competitors trying to make profits for themselves by designing, building, and selling locomotives. If they could sell you 20 high-wheeled Challengers to move tonnage which could be moved more profitably with 15 or so modern compound 2-8-8-2's, they were going to do their utmost to sell you the 20 Challengers. It's obvious that Alco could make more profit by selling Union Pacific 25 4-8-8-4's than it would have by selling the same

ABOVE AND BELOW, BRUCE R. MEYER

For all their power, the N&W Y's were remarkably nimble and compact. Y-6 2148 (left) snakes through a 12-degree curve on the Dry Fork Branch south of Iaeger, W.Va., on March 26, 1959. A broadside view of Y-6 2136 (below) shows off her length of 67 feet, 5 inches—not quite 1 foot longer than a Union Pacific 4-8-4.

number of smaller, lighter but equally capable compounds for the same job.

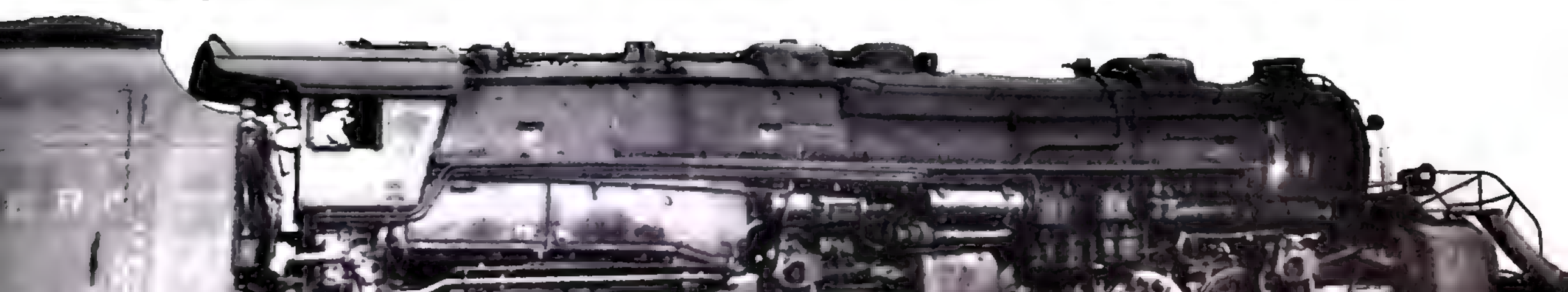
This is not to imply that an N&W Y-6b as finally configured would have met every road's needs. But putting, say, 62-inch drivers under a Y-6 boiler would raise the locomotive only 2 inches and lengthen each group of coupled drivers by about a foot. The Y-6 cylinder dimensions and 300 psi boiler pressure would still result in a much more economical locomotive with a horsepower curve the owner would have utilized on every trip.

There were five differences between N&W's Y-6 family and the old, slow compounds everybody disdained. In chronological order these were: (1) the use of high boiler pressure; (2) the bridgepipe low-restriction exhaust system for the low-pressure engine; (3) the annular-ported exhaust nozzle; (4) limited cutoff; and (5) the redesigned intercepting and reducing valves and the booster valve.

It took more than 35 years of careful research and engineering to develop the Y-6b from the original Y-2 of 1918. This development was accomplished because the railroad thought the results would be worth it. N&W's operating and financial results say that it indeed was. But none of these concepts was a secret; any designer working independently could have achieved similar, or maybe even better, results. It can only be speculated that the builders knew early on that they could make more money for themselves by building the larger, heavier, and more expensive simple articulateds. They put all their sales efforts into doing just that—selling the railroads speed they didn't need. High horsepower is of little value if the locomotive is going to spend most of its time operating below the peak of its horsepower curve. Bragging rights and profits don't necessarily go hand in hand.

The Y-6 wasn't pretty, but N&W didn't care about pretty. The Y-6 wasn't esteemed among the dictators and arbiters of steam-locomotive fashion, but N&W didn't care what was fashionable. What the Y-6 was, was a moneymaker—more so than any other mountain steam locomotive around—and that's what N&W *did* care about.

It is a tribute to the marketing efforts of Alco, Baldwin, and Lima—selling Super-Power and the high-wheeled simple articulated—that no other railroads shared Norfolk & Western's faith in compounding. It was their loss. ■



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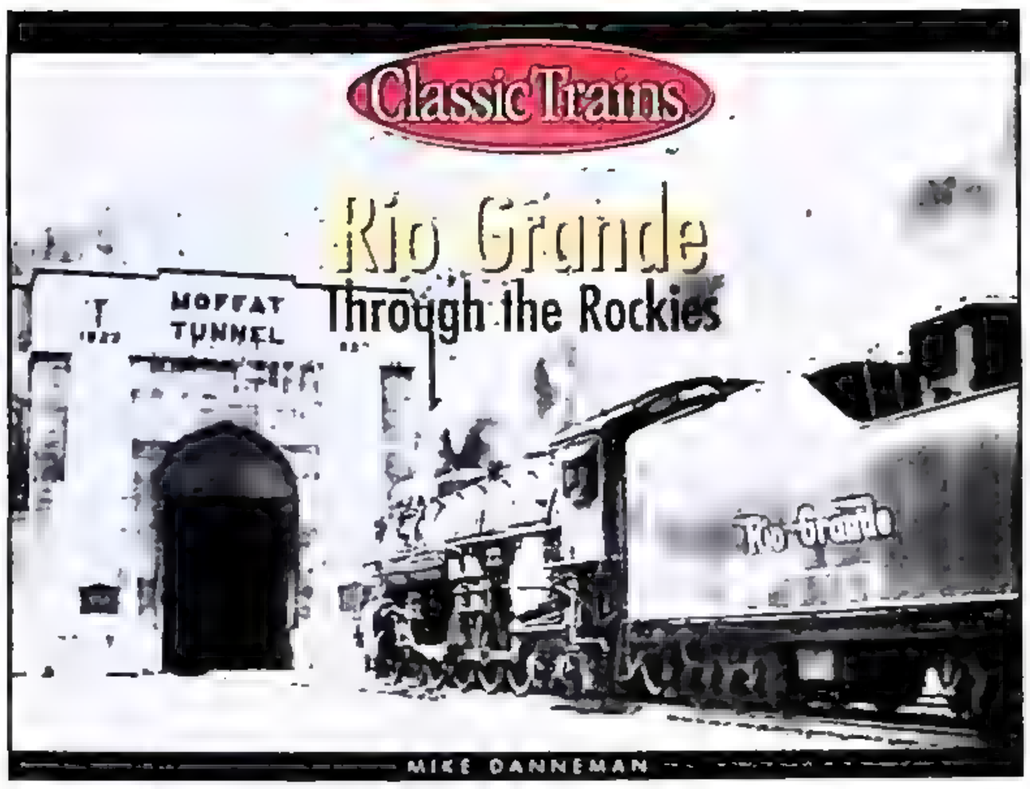

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Chessie's twin STEAM

C&O's big boats of 1952 were the last word in carferries, and one of them still sails

HERE'S AN ANOMALY. In 2003, over 40 years after America's mainline railroads ceased using steam locomotives in regular service, steam engines still power a former Chesapeake & Ohio Railway steamer in everyday use over one of the routes it was built for over a half century ago.

The vehicle, of course, is not a locomotive but a ship—or "boat" as even the largest fresh-water vessels are typically called on the Great Lakes. A onetime railroad carferry, the vessel is the *Badger*, which carries trucks, automobiles, and passengers across Lake Michigan in the warm months between Ludington, Mich., and Manitowoc, Wis. Launched in 1952, the *Badger* and identical sister *Spartan* were the final enhancement to a cross-lake railroad-car shuttle begun in the late 19th century. Today the *Badger* flies the flag of Lake Michigan Carferry, which returned her to cross-lake service on May 15, 1992, after a hiatus of almost two years.

Although railroad cars will never again fill the *Badger*'s deck, the ferry betrays the time and aegis of its construction in many ways. Not only is she steam-powered, she's a reciprocating steamer—an "up-and-downer," as such vessels were known on the Lakes before they were made obsolete by steam turbines and then diesel engines. Further, she is coal-fired—a sure tip-off of her C&O heritage. The vessel has other railroad-related features as well, such as a streamlined aesthetic typical of 1950's trains. Anyone occupying one of the *Badger*'s 44 cabins will be put in mind of a Pullman car by beds that fold out of the wall, sofas that make up into berths, and the staterooms' general compactness.

RAILROAD FERRIES across Lake Michigan date to 1892, when the Toledo, Ann Arbor & Northern Michigan (after 1895, the Ann Arbor Railroad) began service from Elberta (Frankfort), Mich., to Kewaunee, Wis., where

ABOVE, KARL ZIMMERMANN, BROCHURE, CLASSIC TRAINS COLLECTION

connection was made with the Kewaunee, Green Bay & Western. Ann Arbor's railroad ran from the lake port diagonally across lower Michigan to Toledo, Ohio, so the carferries were integral to its operation. Eventually, AA established routes to other west-shore cities: Manitowoc and Green Bay, Wis., and Menominee and Gladstone, Mich. (later abandoned in favor of Manistique).

Ann Arbor's first boats were two identical wooden-hull vessels; each could carry 24 freight cars. Carferries built for short trips across relatively sheltered waters, such as the Straits of Mackinac, loaded cars through openings in the bow. The AA boats were stern-loaders, in deference to the open waters they would cross. All the Lake Michigan carferries that followed would share this characteristic.

The *Badger*'s lineal descent goes back almost as far as the Ann Arbor boats. When the Pere Marquette Railway was formed in 1900 by the combination of three roads, two

Wearing Chessie System heralds on their funnels, C&O carferries *Spartan* (left) and *Badger* steam at Ludington in August 1978. A brochure from 1953 promoted the C&O boats to motorists.

were already operating carferries on Lake Michigan. The Flint & Pere Marquette Railway, chartered in 1857 to haul lumber from Flint, reached its namesake Lake Michigan port of Pere Marquette in 1874, by which time the town was being called Ludington. The following year F&PM got on the lake with a chartered sidewheeler, and by 1890, it had built its own fleet of five "break-bulk" steamers, boats that required transloading of commodities.

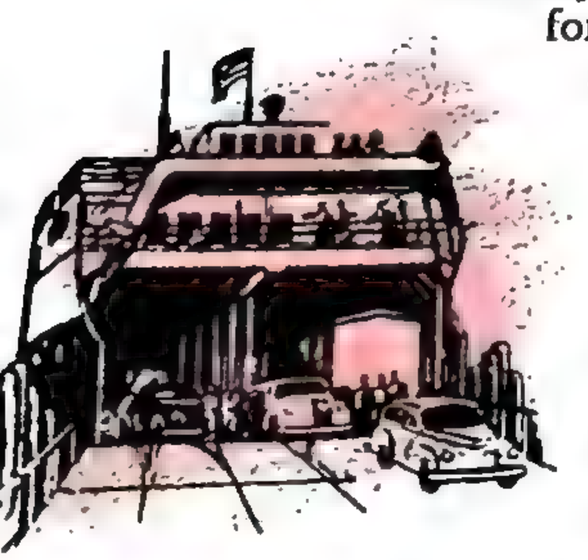
When lumbering played out and F&PM shifted emphasis to its cross-lake connection, this transfer became increasingly problematical, and in 1896 F&PM launched the

CHESAPEAKE & OHIO HISTORICAL SOCIETY COLLECTION

The *Badger* hits the water for the first time on September 6, 1952, at the Christy yard in Sturgeon Bay, Wis. Sister *Spartan* (background) was christened the same day.

ferry *Pere Marquette*. Its main advance was a steel hull, a key for ice-breaking, important for maintaining year-round service. This vessel proved a prototype that nearly all Lake Michigan carferries would follow for decades: twin stacks and a single cabin deck. With four tracks, the *Pere Marquette* was 337 feet long and 56 feet wide, with a capacity of 30 standard 40-foot freight cars—numbers that would change little in the decades ahead. The *Badger* measures 410 feet, 6 inches by 59 feet, 6 inches and could carry 34 cars on its four tracks. Tight turning areas and shallow depths at the ports were the limiting factors for these dimensions.

The *Pere Marquette* plied between Ludington and Manitowoc, a route that stayed important for Pere Marquette and then C&O after it took control of PM in 1924 (C&O fully merged PM in June '47). Meanwhile, another PM predecessor, the Detroit, Grand Rapids & Western, had begun operating the carferry *Muskegon* in 1895 between Muskegon and Milwaukee. After the 1900 consolidation that created the PM, this vessel became *Pere Marquette 16*, and the *Pere Marquette* eventually received the suffix *15*. By 1903, four similar sisters were in the fleet.



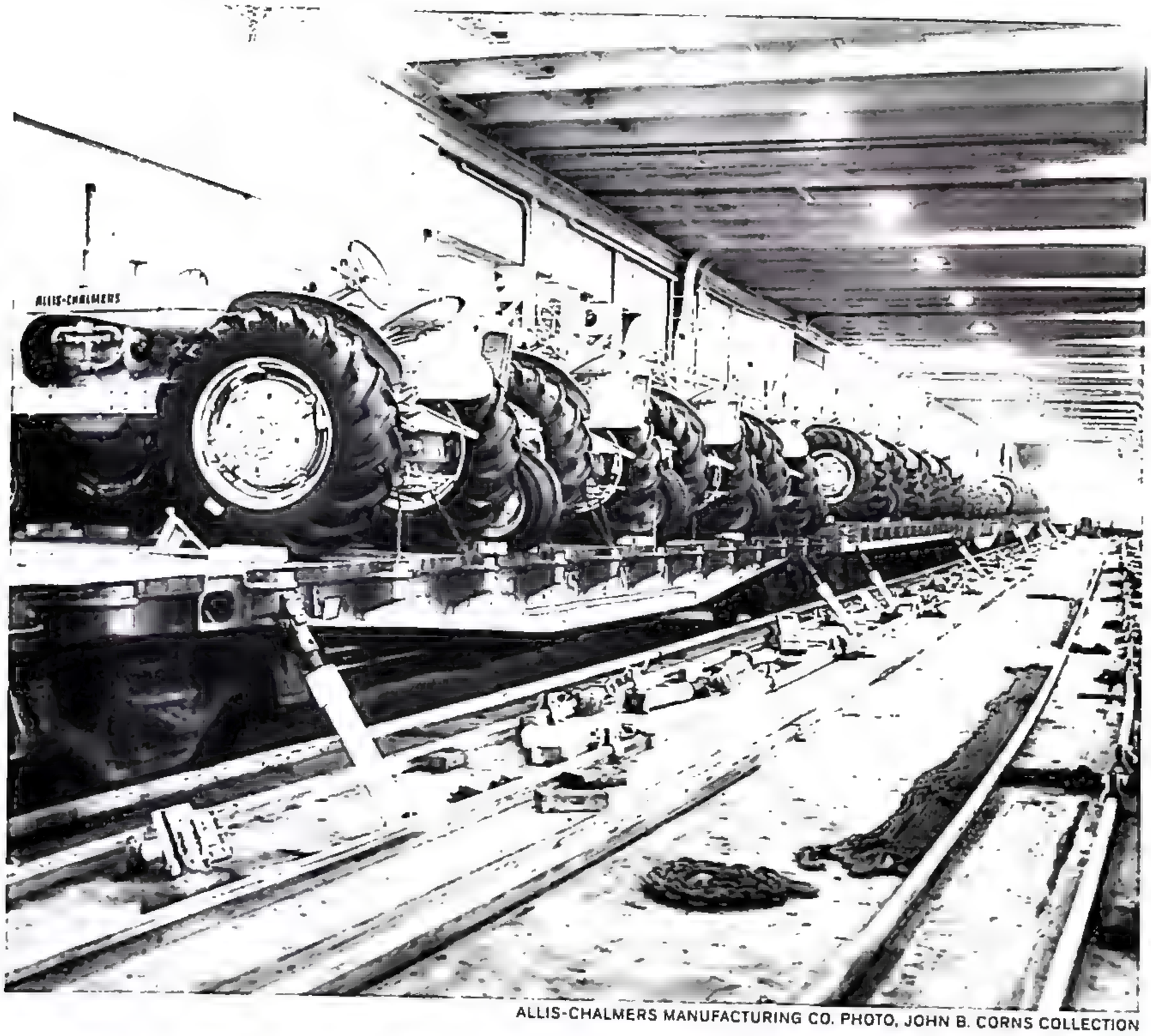
Early in the PM era, the Milwaukee boats were shifted from Muskegon to Ludington. When Kewaunee was added in 1903, the three routes that would remain to the end of service (by then operated by successor Chessie System) were in place.

In 1924, "on-line" Manitowoc Shipbuilding Co. designed and delivered *Pere Marquette 21* and *Pere Marquette 22*. Similar to the earlier PM boats but slightly larger, they would be replicated four more times, as *Ann Arbor No. 7* and the Grand Trunk Western trio *Grand Rapids*, *Madison*, and *City of Milwaukee*. (The *Milwaukee* survives in preservation, currently in Manistee, Mich.) GTW subsidiary Grand Trunk Milwaukee Car Ferry Co. had begun Lake Michigan service in 1903, to Milwaukee from Grand Haven, later switching to Muskegon as its Michigan port when the Pennsylvania Railroad became a partner in the service.

The six were elegant vessels, especially considering the design restrictions. Car decks had to be level, eliminating the possibility for the graceful, sweeping sheer that enhances the best marine architecture. The need for four parallel tracks to fill as much of the hull as possible enforces a certain boxiness.

In 1929, Manitowoc delivered to PM *City of Saginaw 31* and *City of Flint 32*, and while they were arguably less successful, they were clearly the beginning of a new era for Lake Michigan carferries—one that focused on passengers, not freight (a market only PM, not Ann Arbor or GTW, really sought).

The freight-traffic objective was to avoid the rail bottleneck of Chicago. By the 1920's, though, automobile tourism was beginning to grow, and the *Saginaw* and *Flint* responded to this by offering a general upgrading of passenger accommodations, including 43 staterooms. By this time, the PM and the American Automobile



ALLIS-CHALMERS MANUFACTURING CO. PHOTO, JOHN B. CORNS COLLECTION

On one of her first trips from Milwaukee, the *Badger* was loaded with a solid cargo of flatcars bearing Allis-Chalmers tractors. Jacks, chains, and other car-securing apparatus are visible in this photo.

Association were jointly issuing brochures with maps of the Upper Midwest that showed the saving in time and mileage by sailing on the boats.

Equally a departure—though, as it turned out, not trend-setting—was the boats' propulsion. Though still coal-fired, these two craft were turbo-electric-powered and had automatic stokers. They set the new speed standard for the lake—18 mph, up from 14. They were the first with single stacks. They were the first in the PM fleet to carry names as well as numbers, and their numbering in the 30's further distinguished them from their predecessors.

FOR ALL THESE INNOVATIONS, these twins still looked a lot like traditional carferries. In appearance, the breakthrough came in 1941 with the stylish *City of Midland 41*—once again, a vessel worth being numbered for a new decade. The *Midland* would be the prototype for the *Badger* and *Spartan* just over a decade later.

The *Midland*, last of the Manitowoc Shipbuilding boats, was the first Lake Michigan carferry to spread passenger accommodations over two decks. She had 72 staterooms, including a dozen "master rooms"—parlors with private

CHESAPEAKE & OHIO PHOTO, JOHN B. CORNS COLLECTION

A C&O hopper car, its load of coal perhaps destined for the *Badger's* own bunkers, leads the way onto the boat at Ludington. The like-new condition of the automobile ramp dates the scene to 1955 or '56.

KARL ZIMMERMANN

C&O variously used the terms "auto ferry," "trainferry," and even (in the Chessie era) "the good ferry" in marketing its boats to the public. One of the names appears in stylish C&O script on the automobile ramp at Manitowoc in May 1979.

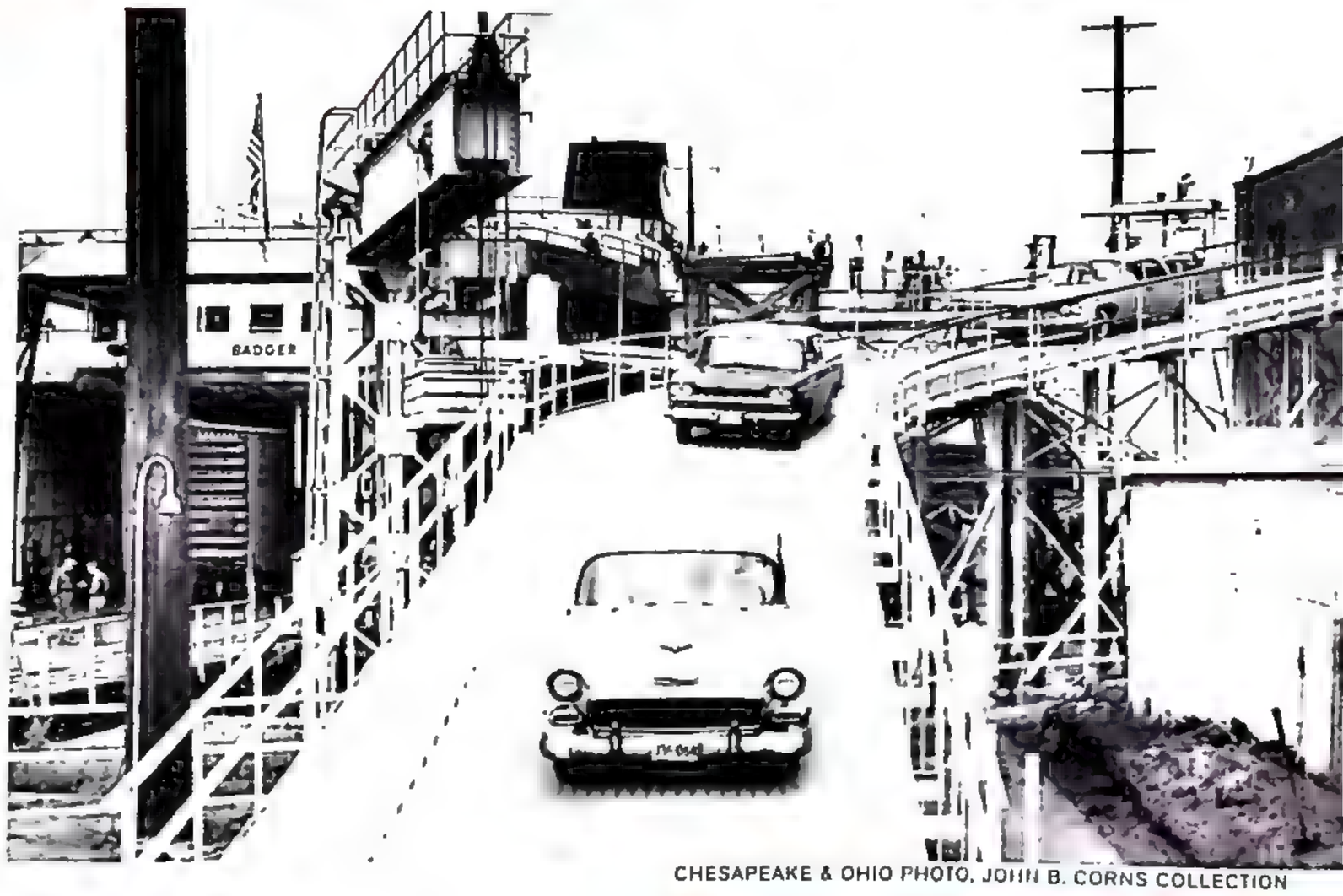
Shortly after the 1960 installation of the auto ramp at Milwaukee, a Chevy, Rambler, and Plymouth station wagon roll off the *Badger*. Crewmen rode back up to the deck on a "manlift," a vertical conveyor belt with hand- and footholds. Ramps were built at Ludington, Manitowoc, and Milwaukee; Kewaunee never got one.

showers (railroad master rooms, rare and always deluxe accommodations, also typically had showers). The aesthetic throughout was streamlined moderne. The lounge and dining room were spacious and comfortable.

Another innovation was provision on the Boat Deck for 50 automobiles. Wartime gasoline rationing depressed auto travel, and it would be many years before the spidery, curved ramps to allow access to the Boat Deck were constructed. Crew members, not motorists, loaded and unloaded the autos, whether on the Car Deck or the Boat Deck.

Below the waterline was another innovation. Since the turbo-electric plants of the *City of Saginaw 31* and *City of Flint 32* had been found wanting, the *Midland* was fitted with two Unaflow reciprocating steam engines made by the Skinner Engine Co. Their quick reversing capability made them ideal for carferry service, where boats routinely docked stern-first, without tugs, and in winter often had to jockey back and forth to work through ice, in port and out on the water. (These factors mandated other aspects of carferry design: bows designed to ride up onto ice and crush it with the boat's weight, and twin screws, individually controlled, to aid in maneuvering.)

From the outside, the *Midland* was clearly a horse of a different color. In view of the design constraints, she appeared remarkably streamlined. Her turreted wheelhouse was tapered. A sweeping white band on the upper hull and Spar Deck gave an illusion of sheer, and a shorter, tapered, swept-back funnel capped a decidedly sleek look. The *Midland*'s dimensions—406 feet long, with a tonnage of 3968—made her the largest carferry on the Lakes.

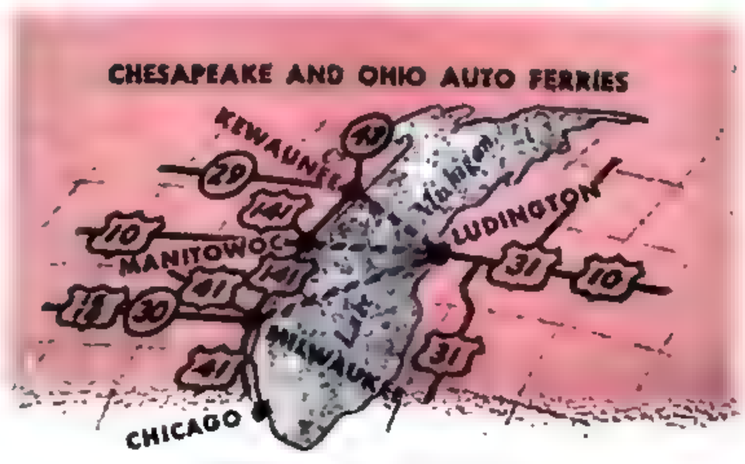


CHESAPEAKE & OHIO PHOTO, JOHN B. CORNS COLLECTION

THE *CITY OF MIDLAND 41* proved successful and popular, setting the stage for the last and largest of the ferries: the *Spartan* and *Badger*, closely modeled on the *Midland*. Their arrival, plus the upgrading of other C&O boats, ushered in the final golden age of the Lake Michigan railroad carferries.

C&O awarded the contract to build the two boats to Christy Corp. of Sturgeon Bay, Wis., and their construction proved problematical for the firm, though neither the builder nor the railroad had any reservations about the finished products. The largest vessels ever built by Christy, they took shape simultaneously, on adjacent ways.

The *Spartan*'s keel was laid in December 1950 and the *Badger*'s the following April. This led to a January



BRIDGING LAKE MICHIGAN

1952 launch for the *Spartan* and a September one for the *Badger*. The *Badger* progressed more slowly because of changes in the economic landscape. The Korean War inflated costs of material and labor, causing Christy to struggle with its ambitious project. A labor shortage and steelmakers' strike compounded the problems. The war eventually became part of the solu-

Skinner Unaflow: The ultimate 'up-and-downer'

Though Chesapeake & Ohio made a startlingly traditional choice in powering the *Badger* and *Spartan* with reciprocating steam plants (surprising even the boats' marine union, which advocated diesel power, even though this would have meant fewer jobs), it did opt for the most sophisticated expression of that "up-and-downer" technology. This was the Skinner Compound Unaflow Marine Steam Engine.

The Skinner Engine Company of Erie, Pa., introduced its first Marine Unaflow steam engine in 1929. This multi-cylinder, single-expansion engine was called "Unaflow" since the steam took a unidirectional path through the cylinders. Economical, reliable, and relatively maintenance-free, these engines were quickly responsive and thus especially well suited to marine applications where maneuverability was important. Thus Skinner Unaflows were installed in heavy seagoing tugboats, small coastal and inter-island vessels, and inland waterways vessels.

On the other hand, the Unaflow was not appropriate for ocean-going bulk carriers because its inlet steam temperature and pressure were not high enough. After World War II, Skinner responded to this shortcoming (highlighted by the ascendancy of steam-turbine and diesel power plants) by developing a steeple compound engine, similar to those that powered the famous Liberty Ships.

Between 1950 and 1955, a dozen Skinner Compound Unaflow engines were installed in Great Lakes vessels. Two each went into the *Spartan* and *Badger*. (The *City of Midland 41* got single-expansion Unaflows when built in 1941.) The twin carferries' 3500 h.p. Steeple Compound Unaflows would literally prove to be the last word in maritime reciprocating steam. (One other Skinner Unaflow-powered Great Lakes vessel remains in operation: the self-unloading cement carrier now called the *Southdown Challenger*.)

The *Badger*'s two engines each have four pistons powering the crankshaft. In a "steeple compound," each of the piston rods passes through two cylinders: a low-pressure one with (in the *Badger*'s case) a 55-inch diameter piston and, on top of that, a high-pressure one with a 22½-inch diameter piston. The smaller cylinder stacked above the larger resembles a church steeple, hence the name. The cylinders are single-acting, with the high-pressure one working the crank on the upstroke and the low-pressure on the downstroke.

The steam for these then-state-of-the-art reciprocating engines comes from four type D marine boilers made by the Foster-Wheeler Company. The boilers feature economizers that use exhaust gases from the burning coal to preheat the water going in and superheaters to raise the temperature of the steam on the way out. For two round trips across Lake Michigan, the *Badger* uses about 71.2 tons of bituminous coal–once delivered by hopper car through hatches on the car deck, and now by dump truck.

In 1996 the *Badger*'s engines and boilers were recognized as an Historic Mechanical Engineering Landmark by the American Society of Mechanical Engineers–an appropriate honor for machinery that 50 years after its inauguration is still performing admirably in its original role.–*Karl Zimmermann*

A Skinner ad (above right) touted the Unaflow's suitability for the two new carferries. A crewman on the *Midland* (right) uses one of the engines' viewing ports. Unlike earlier steam engines, the Unaflow was mostly enclosed in sheet metal.

CLASSIC TRAINS COLLECTION

CHESAPEAKE & OHIO HISTORICAL SOCIETY COLLECTION

Staterooms on the *Badger* and *Spartan* recalled railroad sleeping-car practice of the day. Functional and efficient, if not luxurious, they were more than adequate for the short crossings. Most passengers simply stayed on deck or in the lounge.

Down on the Car Deck, the atmosphere was less refined. In a view from early in her career, the *Spartan* is ready to depart from Ludington. Increased car height prompted modification of the *Badger* in the 1960's, but *Spartan* remained as-built.

CHESAPEAKE & OHIO PHOTO, JOHN B. CORNS COLLECTION

tion, however, because the military urgently needed additional landing craft, and ordered five from Christy.

This helped the builder weather the financial storm, and on September 6, 1952, the *Spartan* and *Badger* were christened in a joint ceremony. Shedding the Pere Marquette tradition of naming boats for on-line cities, C&O honored the two states served and their universities. *Spartan* recognized Michigan State College's athletic teams, and *Badger* the University of Wisconsin's. No numbers were officially assigned to the boats, and none ever appeared on their hulls, although the *Spartan* was routinely referred to as 42 and the *Badger* as 43. The numbers did appear, instead of the names, on the Ludington arrivals and departures board, in C&O memos, and on linen and equipment.

"I christen thee the S.S. Badger," intoned Mrs. Walter J. Kohler, wife of Wisconsin's governor on that September 6th, and the vessel slid sideways down the ways, sending a huge wave cascading into a string of refrigerator cars spotted to protect a Christy warehouse across the slip. The *Spartan* was ready for sea trials and a maiden voyage in October, but the *Badger* had six months of fitting out remaining before making her first trip on March 21, 1953. The Great Lakes' largest, most modern—and final —carferries were in operation.

At 410 feet, 6 inches, the two new boats were slightly longer than *City of Midland 41*. They were powered similarly, with coal-fired reciprocating steam engines, a decision that in 1953 must have seemed more surprising than it had when the *Midland* was built. Like the *Midland*, their cruising speed was 18 mph.

The *Badger* and *Spartan* were the cornerstones of a $20 million expansion and modernization program undertaken by C&O in the early 1950's for its carferry fleet, but there was more. *Pere Marquette 21* and *Pere Marquette 22* were each stretched by 40 feet at Manitowoc Shipbuilding; given Skinner Unaflow engines, allowing them to achieve the 18-mph standard; and crowned with streamlined funnels. (*City of Saginaw 31* and *City of Flint 32* had been retrofitted with similar funnels in 1942.) The C&O now had a fleet of seven boats capable of 18 mph, all with reasonable passenger accommodations and at least a somewhat modern appear-

C&O steam lives!

Big and brawling, the *Badger* is not the old-fashioned vessel that might leap to mind when you think "steamboat," but it certainly is just that. As a passenger today, you will have an experience much like the boat's first passengers had.

Some things have changed, of course. You can no longer experience the ice-breaking drama of a winter crossing. Gone is the pleasure of watching switch engines push cuts of freight cars across the apron, with great thudding and squealing of flanges, and feeling the boat list underfoot as loading progressed. No more is the routine of securing freight cars with rail clamps, jacks, and chains. When Lake Michigan Carferry Service assumed operations, the Car Deck was paved over, and railroad cars banished forever.

There were other changes, mostly upgrades, as part of LMC's $500,000 refurbishing. The boat's 44 outside staterooms were repainted, reupholstered, and recarpeted. The 16 inside staterooms were removed and replaced by an exhibit area with artifacts, photos, and historical commentary (created in cooperation with the excellent Manitowoc Maritime Museum); a gift shop; a television/video room; and a game arcade. The *Badger's* after Boat Deck was originally designed to carry autos. With the entire Car Deck available for this purpose, LMC enclosed this area under a canopy as additional passenger space. Because of changing tastes and economics, a dining room with linen and table service has given way to a cafeteria.

Though much more "entertainment" is provided now than in C&O days, especially for children, the best entertainment is the same as always–being on deck as the boat steams away from the slip with a single long blast on the horns. Wake churns, the stern sea gate lowers, and the *Badger* is off on its 4-hour crossing, a ritual enacted at each port once daily in spring and fall and twice daily in summer. The smudge against the sky and smell of coal smoke are reminders of the source of her power, as is a certain grittiness on deck. Sharp ears may pick up the trill of telegraph–called a "Chadburn" on the Great Lakes, after the equipment's British manufacturer–as the wheelhouse rings down a "full ahead" to the engine room, and the engineer answers when he's made that adjustment to the throttles.

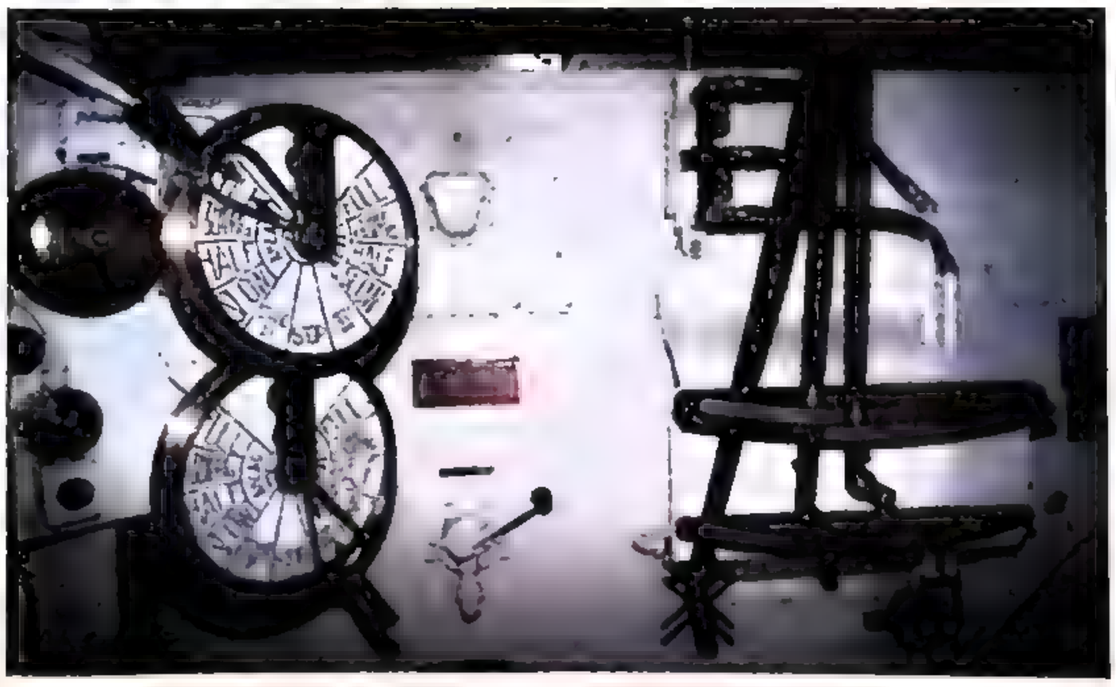
Lake Michigan is big, second largest of the Great Lakes, and in mid-crossing you're well out of sight of land. Though it is not as famous for storms as Lake Superior, don't be surprised if the *Badger* rolls a good deal, its bow rising and falling in rhythm as it plows ahead. Announced by three long blasts on the horns, the "harbor call," arrivals are even more interesting than departures, since the *Badger* must back into its slip. This maneuvering usually involves the anchor clamoring down the hawsepipe, and a slow pivot on a turning dolphin. Finally, the venerable carferry is fast, without tugs but with the time-honored maritime skills that are much a part of its rich tradition.–*Karl Zimmermann*

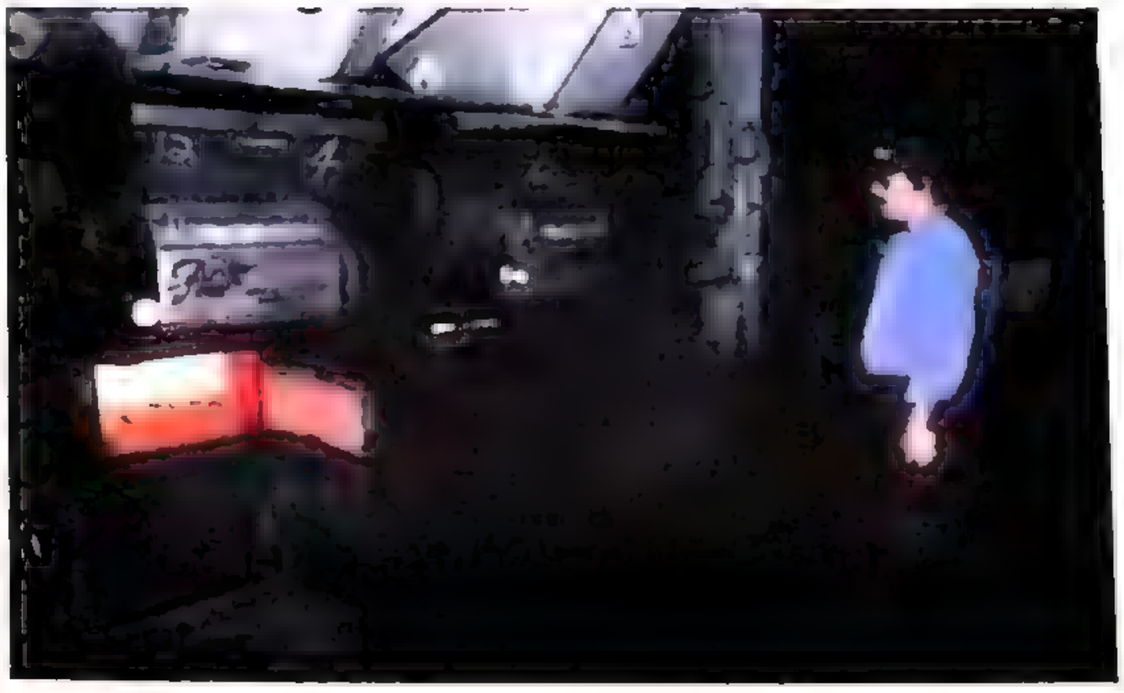
For schedules, call (888) 337-7948 or visit www.ssbadger.com.

***Badger* in the 1990's (clockwise from below left): View aft from wheelhouse (1998); interior of wheelhouse (1993); stokehold ('93); starboard engine telegraph and throttles ('93).**

ROBERT S. McGONIGAL

THREE PHOTOS KARL ZIMMERMANN





CHESAPEAKE & OHIO PHOTO, JOHN B. CORNS COLLECTION

Passengers line the *Badger*'s rail to watch her dock at Ludington. Visible in this C&O-era scene are *City of Midland 41* (left), *City of Saginaw 31*, and *City of Flint 32*.

ance. (The fastest Lake Michigan carferry was Ann Arbor's *Viking*. The 1965 diesel conversion of *Ann Arbor No. 7*, she had a cruising speed of 21 mph.)

THE YEARS immediately ahead were great ones for the C&O fleet, and Ludington was the busiest carferry port in the world. The boats ran 'round the clock, making three round trips a day to Milwaukee (four in summer), a 6-hour crossing. The 4-hour trips to Manitowoc were made twice daily and to Kewaunee once daily. During this period the auto and passenger business swelled, and freight-car commerce held strong. Freight traffic—typically paper products, auto parts, chemicals, and salt westbound and beer, wood pulp, lumber, and heavy equipment east—peaked in 1959, but held up fairly well through the 1960's. In 1961, C&O hauled 132,000 freight cars, 54,000 autos, and 153,000 passengers across the lake.

In 1963 C&O took over the Baltimore & Ohio, beginning a period of coordinated operations. Although this alliance would eventually lead to the ferries' downfall, with B&O's Chicago operations offering a good all-rail alternative, its first effect was positive: bringing B&O's excellent passenger department (run by Paul Reistrup, later president of Amtrak) to bear on the business that was clearly the future hope for the boats. By the early 1970's, however, this department had vanished. Freight railroading had changed, too. The 100-car trains that had become routine were ill-suited for the ferries, and pre-blocking and run-through operations had somewhat alleviated the Chicago bottleneck.

Simply put, C&O had lost interest in running the ferries and would work assiduously to eliminate them until it succeeded in 1983. In March 1975, Chessie System (a parent created in 1973) filed with the Interstate Commerce Commission to eliminate all carferry operations. The ICC in 1978 compromised with what came to be called the "Kewaunee package," allowing C&O to drop service to Milwaukee immediately, to Manitowoc in 1980, and to Kewaunee in 1983. (A key concern for the ICC throughout the abandonment proceedings—which became the longest in the history of American railroading—was protection of the Green Bay & Western, which typically received more than one-third of its interchange traffic from C&O and Ann Arbor boats at Kewaunee.)

After appeals and protests, and some subsidies from the State of Michigan, Milwaukee service (for passengers and automobiles only at the end) finally stopped in October 1980; the last Manitowoc sailing (under what by then was CSX auspices) came in January 1982. That left only the Kewaunee route, which was slated to go the next year. But before it did, a group of Ludington businessmen formed the Michigan-Wisconsin Transportation Company. MWT bought the *Midland*, *Spartan*, and *Badger* from CSX and agreed to lease the Ludington port facilities and assume labor-protection costs for six years—a period for which CSX, on its part, would continue cross-lake shipments.

In July 1983, the *Midland* entered Ludington-Kewaunee service, where it remained until November 1988, when it was replaced by the *Badger*, which for the summer 1983 and '84 seasons had operated auto- and passenger-only service to Milwaukee (the *Spartan*'s fires had been dropped in 1979). Finally, on November 16, 1988, the Kewaunee route was shut for good, either because money had run out or because the Kewaunee channel had silted in, or both. The *Badger* was tied up, and it seemed that Lake Michigan carferry service had finally come to an end. (Grand Trunk Western had quit in the mid-'70's, Ann Arbor in 1982.)

One more miracle remained, thanks to the late Charles F. Conrad, a self-made millionaire from Holland, Mich., whose father had been a chief engineer on the PM boats. He bought the three ex-C&O ferries and, on May 15, 1992, began seasonal Ludington-Manitowoc service as Lake Michigan Carferry Service with the *Badger*, which has continued to soldier on, alone (the *Spartan* remains moored at Ludington as a parts source for her sister). In 1997, *City of Midland 41* was converted to a barge, sans superstructure and the hull truncated to the car deck, a sad end for arguably the most beautiful of all the carferries.

But the *Badger*, a stubborn survivor from the age of steam, appears to have a future, booming across Lake Michigan during Midwestern summers, keeping the memory alive of a unique and charismatic chapter in railroading. ■

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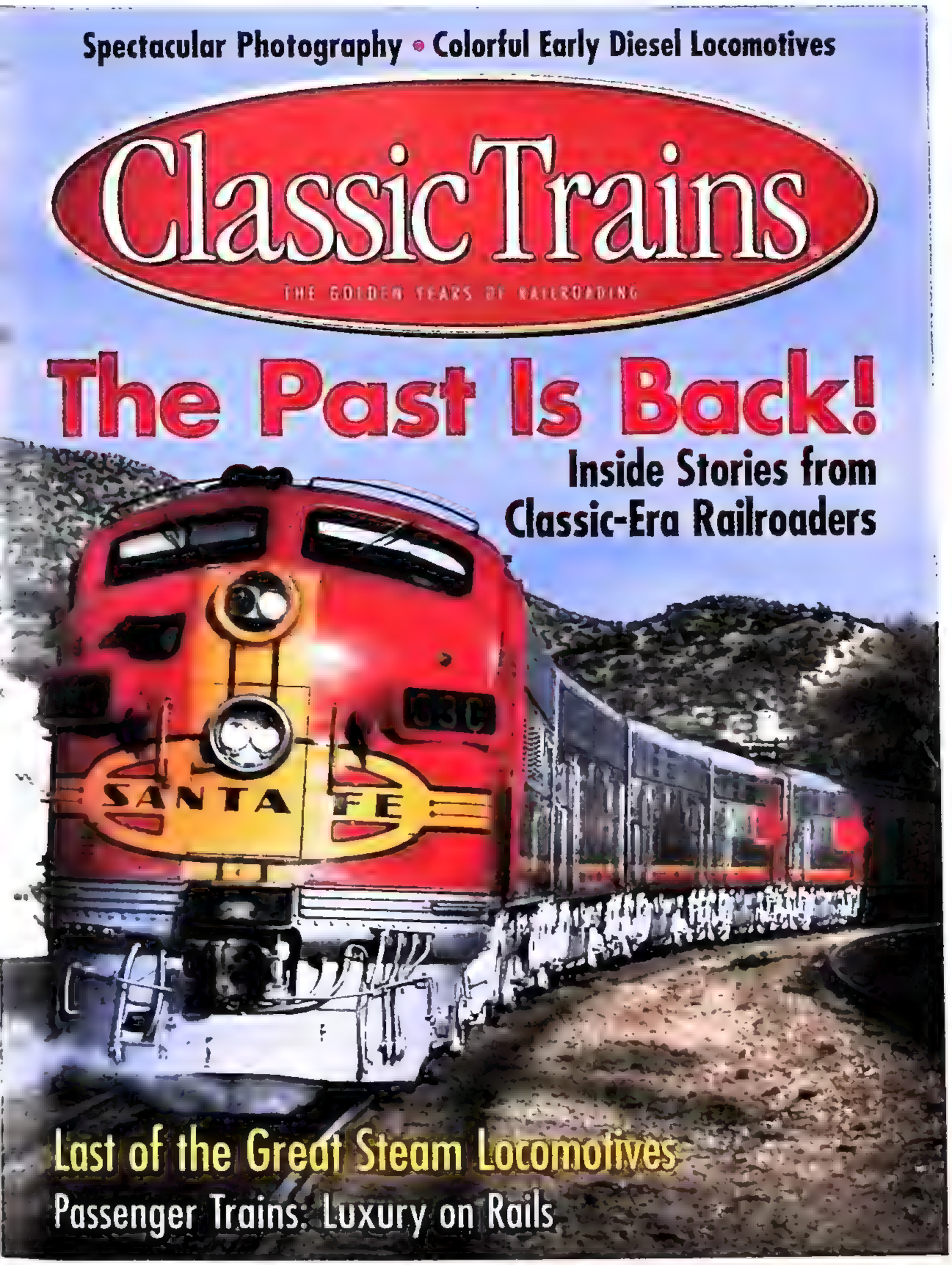
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Going out in **GLORY**

Yellowstone finale

Riding a Missabe 2-8-8-4 in command of 190 cars of iron ore—just before diesels took over

BY **WILLIAM D. MIDDLETON**
PHOTOS BY THE AUTHOR

THE TIME WAS spring 1959, the start of what would prove to be the last season for steam on northern Minnesota's Mesabi Range. Growing ranks of diesel-electrics had been handling all the iron-ore traffic until the United Steelworkers began threatening a strike. Nervous big-steel companies began stockpiling ore and other commodities. Activity had picked up all the way back to the mines, and it was time for the Duluth, Missabe & Iron Range to reactivate some of its stored steam power.

Thus I found myself, on assignment for TRAINS magazine, in the yard at Fraser, Minn., on the late afternoon of May 26. I had ridden Missabe M-4 class 2-8-8-4 Yellowstone No. 228, a 1943 Baldwin, up from Proctor Yard near Duluth earlier that afternoon as it hauled a train of empties north. The crew had turned the locomotive, taken on coal and water, and backed 228 onto a southbound ore extra at 6:05 p.m. Behind the articulated's drawbar stretched 190 70-ton-capacity ore "jennies," which added up to a gross train weight approaching 18,000 tons.

The skies had been gray with overcast all day, but the sun emerged briefly to highlight the scene as the big Yellowstone's smokebox-mounted air pumps hammered away at the job of pumping up the train line.

Getting 190 loads out of Fraser was going to be interesting. Engineer Ed App had a 0.8 percent grade facing him, complicated by wet rail from the day's intermittent rains. At 7:32 p.m., the air test completed, the CTC signal flashed green. App took slack, cut in his sanders, and eased

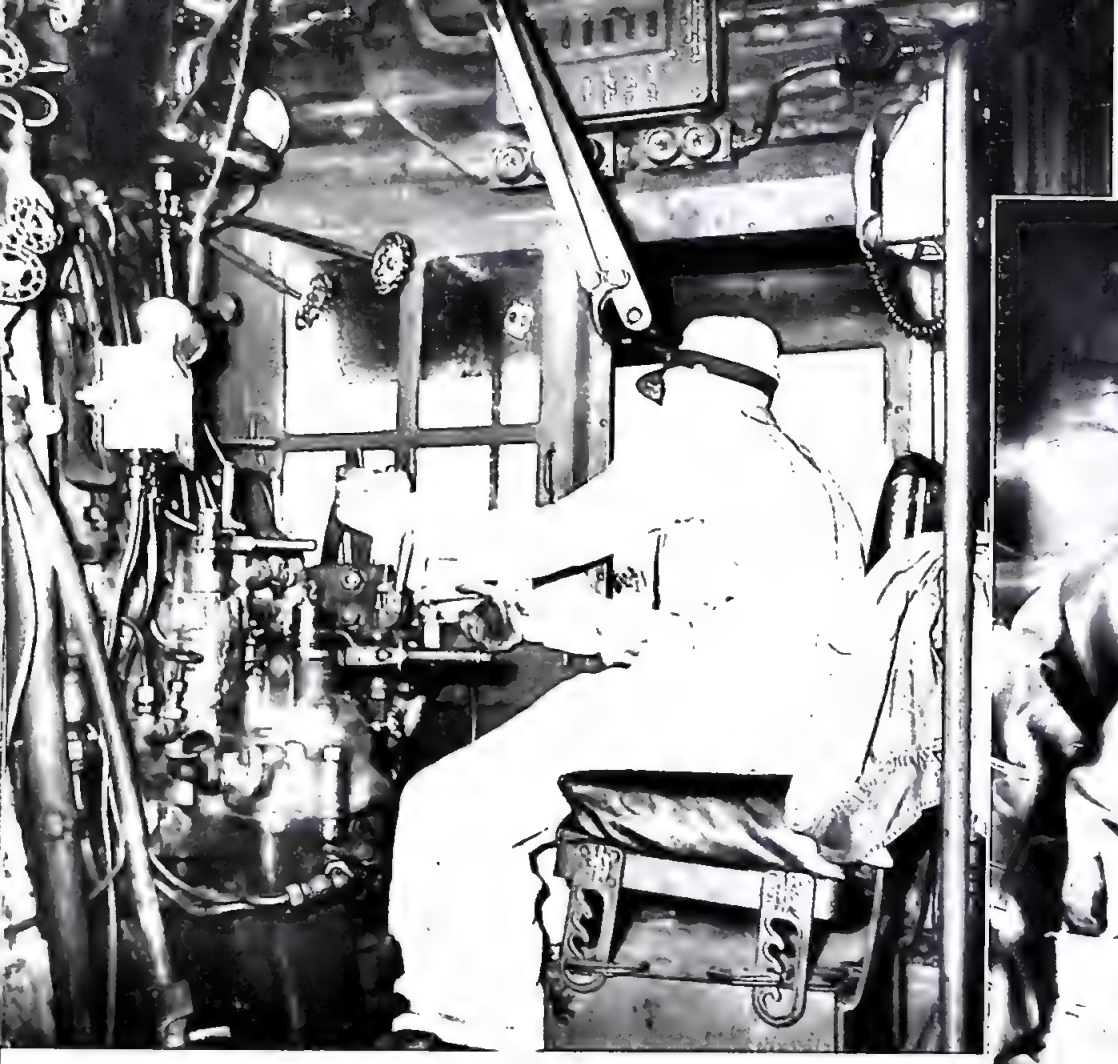
Menaced by an SD9, Missabe 2-8-8-4 No. 228 pumps up the air on its 190-car ore train before departing Fraser for Proctor.

open the throttle. The M4 moved forward a few car-lengths . . . and quit. No go.

App heaved back the reverse lever and took slack again. This time, he made it. Steam enveloped the cab as App cleared the cylinder cocks, and the 2-8-8-4 began to pick up a speed. Its front engine erupted into furious motion as the drivers lost their grip on the wet rail on the switches. App eased off a little on his throttle, but the front engine lost its footing again . . . and again. Fighting to keep moving, 228 hammered through Buhl at a slow walk. A small boy stood awe-struck on the station platform, committing to memory the unforgettable sight and sound.

Now it looked as if App and the 228 were losing the battle. Again and again the drivers slipped on wet rail, and seconds seemed to separate each blast from the stack as the heavy train pulled the locomotive to little better than a crawl. App, one foot propped in front of him to gain leverage, tried to find just the right throttle setting short of the point where the front engine went out from under him.

Grade crossing ahead! App made frantic motions who reached for the whistle valve. The low moan from the whistle told that the boiler pressure was something less than 240 pounds. A Chevy pulled up short as the Yellowstone inched across the pavement. The driver surveyed the endless string of creeping ore cars in disgust and jerked his car



Two men and their machine: Engineer Ed App, his left hand on the reverse lever and right hand on the whistle valve, rolls 200 empty ore cars north from Proctor. Later, fireman John Shovein checks his fire before leaving Fraser with the loaded train.

way across the track. He would've had a long wait.

Then suddenly, the battle was won. The hill began to level off, and gradually the exhaust cadence quickened. The grade tipped the other way, and App shoved in the throttle and started working the air to hold his train back.

Approaching Sherwood, a yellow-over-green signal indicated the plant was lined for the Keenan Cutoff. The red-over-yellow home signal swept by, and fireman Shovein leaned out in response to a flashing yellow order board to snare the 19 order that told us to run extra to Proctor. App flicked on his cab light, read the order, and passed it around the cab.

Extra 228 South had a slight grade working in its favor on the cutoff, and the cab filled with smoke as App shut her off and drifted. The roar of the stack faded, replaced by the sharp hiss of air as pistons flashed back and forth in empty cylinders.

At 8:15, App sent superheated steam rushing into the cylinders again as his steed approached the junction at Keenan and lurched through the switches to the left-hand main, the usual DM&IR operating practice. The 2-8-8-4 then set a steady pace as she rolled off the miles of nearly level and tangent track, with the Valve Pilot speed recorder showing a steady 27 to 28 mph (the limit for loaded ore cars was 30). If the 228 had had the devil's own time getting started, she was really rolling now.

Occasionally the cab filled with an orange glare and sudden heat as Shovein cracked the Butterfly doors to check his fire. Beyond the headlight's beam, the red lights of crossing gates would flash, and then the gates would drop into place, a flashing white light on the side indicating the flashers were working.

"All black," called head brakeman Ken Montgomery as the Yellowstone leaned into a curve and he looked back over the train, checking for sticking brakes or hot journals. Ahead, a farmhouse stood out momentarily as the headlight beam swept around a curve. Green interlocking signals and a clear order board led us through Alborn and Coleraine Junction. It was 9:05 p.m., and the Saginaw hill was just 10 minutes away. This was 4 miles of 0.3 percent grade between Burnett and Saginaw that constituted the line's ruling southbound grade. That may not seem like much, but it is when you try to make it with a boatload of iron ore.

Suddenly the battle was won. The hill leveled off and the exhaust quickened.

Crackling lightning to the south had given way to more rain. Wet rail was going to make the hill just

Mission accomplished: App looks over the 228 after arrival at Proctor. Missabe's 18 2-8-8-4's were its last new steam power.

that much tougher. App had the tonnage rolling for all it was worth as the 2-8-8-4 charged through Burnett and stormed the grade.

Slowly the grade cut into the Yellowstone's speed. The exhaust that had been a continuous rush of sound became a series of separate and distinct reports, as the stack hurled soot and cinders into the sky. Steaming beautifully, the big locomotive never faltered as App laid a fine stream of sand on the wet rail from the sanders and adjusted the throttle and the reverse lever to get the last ounce of tractive force.

Wham! With a sound like a minor explosion, 228 slammed under the Highway 33 overpass. Smoke and steam swirled through the cab. Cinders pelted the cab roof as they rebounded from blast plates under the concrete bridge. It was just a little over a mile to the crest now.

Minutes later, the Saginaw depot loomed in the headlight beam, and the M-4 topped the grade with a few miles per hour of momentum to spare. Ed App eased off the throttle and looked distinctly relieved. From Munger to Proctor, Extra 228 rolled downgrade through what was now a fierce downpour. App closed the throttle and worked the air to hold the tonnage in check.

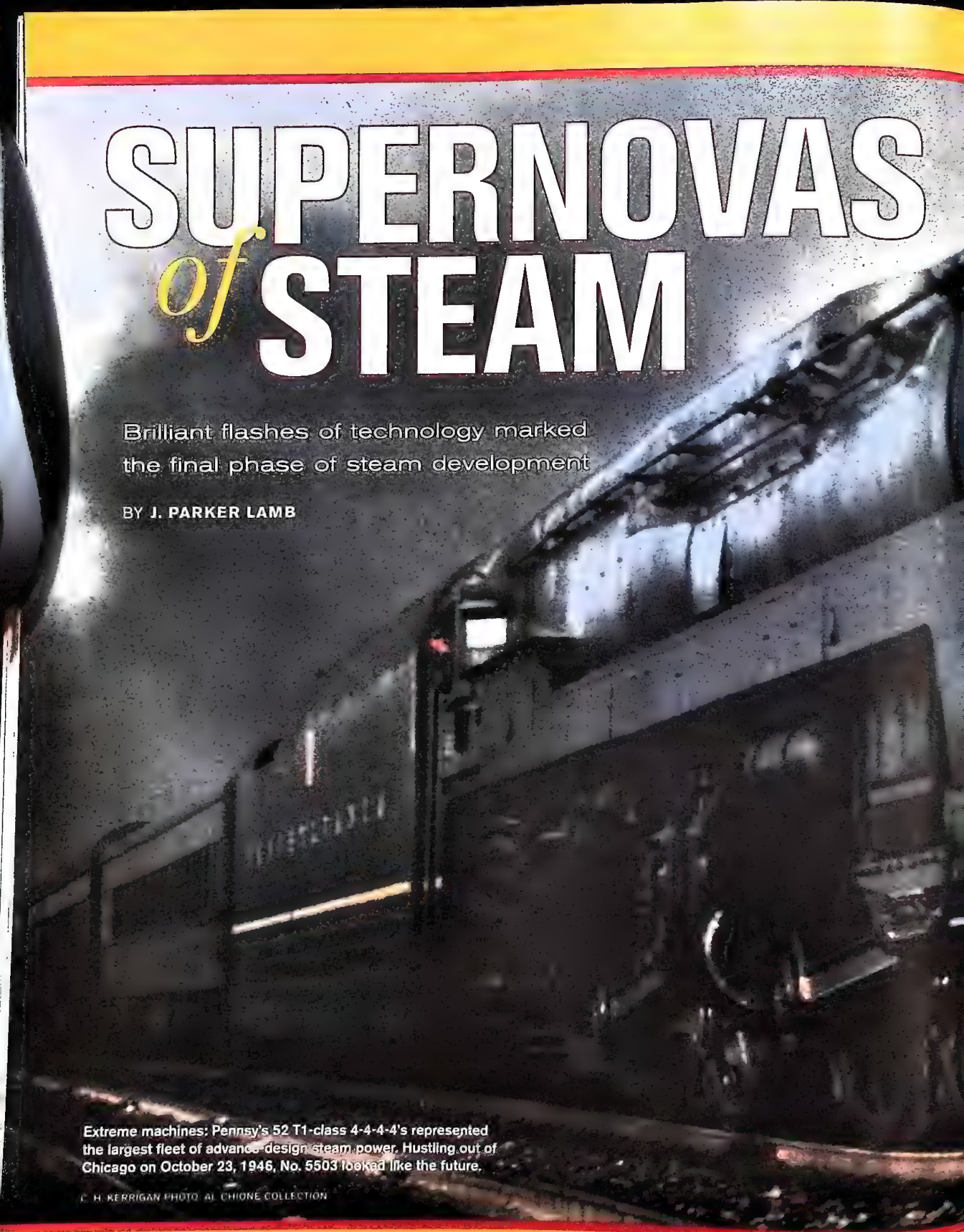
It was 10 p.m. sharp when Extra 228 ground to a stop short of the scale house at Proctor yard. A half hour later, the 2-8-8-4 moved across the scales at a steady 3 mph with half the extra's consist. A yard crew would complete the weighing. By 11:15, the job was done, the Yellowstone was in the roundhouse, and the crew was calling it a day. When the scale house figures were totaled, Extra 228 had weighed in at 17,468 tons. Ed App, John Shovein, and their 2-8-8-4 had moved all that ore 68 miles in just two and a half hours.

On any railroad, Extra 228's run would represent a phenomenal performance, but for the Missabe's big 2-8-8-4's, it was the daily routine. Soon they would be gone from the Iron Range, but the experience of this Yellowstone finale was one that will stay with me forever. ■

SUPERNOVAS *of* STEAM

Brilliant flashes of technology marked the final phase of steam development

BY **J. PARKER LAMB**



Extreme machines: Pennsy's 52 T1-class 4-4-4-4's represented the largest fleet of advance-design steam power. Hustling out of Chicago on October 23, 1946, No. 5503 looked like the future.

C. H. KERRIGAN PHOTO, AL CHIONE COLLECTION

THIS ARTICLE IS ADAPTED FROM THE AUTHOR'S BOOK *PERFECTING THE AMERICAN STEAM LOCOMOTIVE* (INDIANA UNIVERSITY PRESS, 2003)

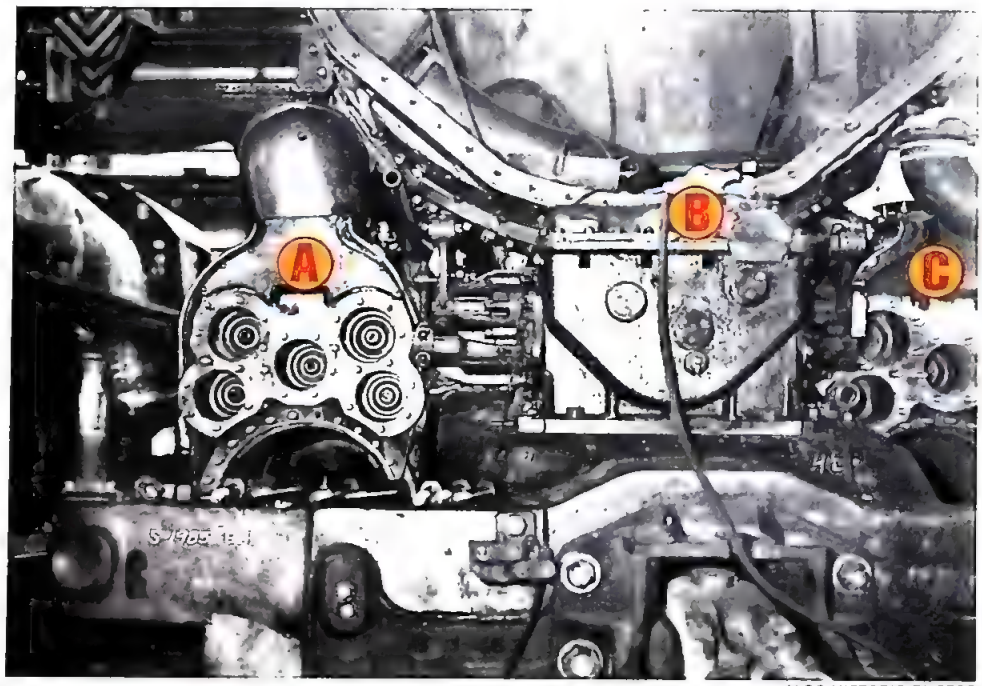
Poppet valves helped make PRR 5399 the most powerful Pacific ever, but other modifications clouded the poppets' role in her performance.

PAUL EILENBERGER

THE SUBJECT OF great steam locomotives usually calls to mind the decade beginning in 1935 when Super-Power types such as the Berkshire, Hudson, Northern, and Texas were the new standard for many roads, and monster articulateds such as Allegheny, Big Boy, Challenger, and Yellowstone became the heavy lifters. Most think these designs represent the pinnacle of American steam development, and in terms of their service in World War II, they performed as none others before or since. But a closer look into the evolution of locomotive technology reveals that, even as the diesel was relentlessly advancing, steam advocates were pushing this vintage machine to even higher levels of development. These final steam designs are often overlooked because of the rushing tide of change that engulfed and overshadowed their brief performance record.

By the late 1930's, locomotive designers knew there were performance limits to the Super-Power designs. Railroads were demanding engines that could maintain high horsepower at ever-increasing speeds. Wartime refinements brought limited successes and a clearer focus on the two main limits to performance at high speed—valve-gear effectiveness and dynamic loads produced by driving wheels at high speeds. The first reduced steam flow, hence power, while the second led to significant roadbed degradation.

The most important controls on a steam locomotive are those that modulate the valve motion. During the last decade of steam-locomotive production, designers tried many ideas for getting steam into and out of the cylinders in a precise way during high-speed operation, but none was completely successful. The major reason for such a speed limit on reciprocating steam engines is that the large moving parts (power pistons and piston valves) have tremendous inertia and resist rapid changes in direction. For example, after the power piston stops at the end of one stroke, it must almost instantaneously accelerate to high speed (over 1000 feet per minute) in the opposite direction, then decelerate and stop again, before repeating this motion. During a very brief part of each stoke, a carefully measured amount of steam must be admitted in a way to act on the entire piston face.



ALCO HISTORIC PHOTOS

PRR was not alone in tinkering with poppets. Front view of NYC 4-8-4 5500 shows right-side poppet valves (A), control box (B), and part of the left-side poppets (C).

On the reverse side of the piston, the exhaust steam must be allowed to exit the cylinder in an equally brief period after it has expanded to a predetermined low pressure. At high speed the usual piston valves and associated valve gear cannot respond to these rapid movements in a precise way. The result is that the steam does not enter

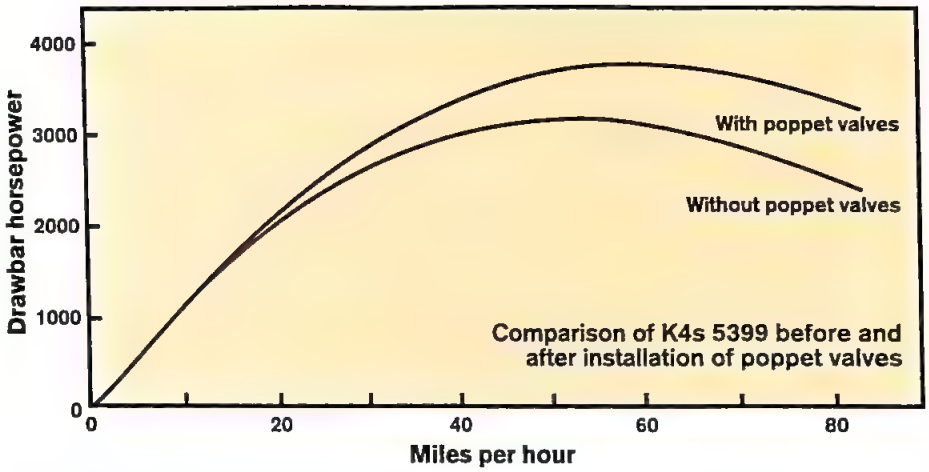
or exit the power cylinder with the proper timing, and thus the power produced in each stroke is diminished.

POPPET VALVES EMERGE

The most obvious solutions envisioned by designers were to reduce the mass (and inertia) of the valve itself, and replace the inertia-laden valve-gear linkage with a smaller, but functionally equivalent, control system. They turned for guidance to the most common high-speed reciprocating machine of the period, the automobile engine. In such engines, each power cylinder receives air through an intake valve and exhausts through an outlet valve. The valves themselves are thin disks that are activated by an integrated push rod (tappet). This configuration is known as a poppet valve and, when enlarged to 6 inches in diameter with foot-long tappets, could be applied to a steam locomotive.

With traditional valve gears, a locomotive engineer could control the cutoff position of steam admission to the cylinder, but there was no control over the exhaust process. With the poppet-valve system there were separate intake and exhaust valves (often four per cylinder) driven by separate cams. The system thus provided a more precise timing of all events associated with steam passage through the cylinder. Just as an automotive engine drives its valve motion using a cam shaft connected to the crankshaft by a timing chain, a locomotive must contain the same functional elements, with the timing chain being replaced by another type of mechanical signal from the driving gear.

One of the earliest poppet valve gears was created by the Italian engineer Arturo Caprotti in the 1920's. In this design there was a long connecting rod between the eccentric crank (main driver) and the cam chamber at the cylinder. It was applied to two U.S. locomotives in the late '20's, but was removed after a year of testing in each case. One of the main complaints was its lack of robustness, because of the larger forces within American engines compared with their European counterparts.



The primary American attempt to develop reliable and accurate poppet valve controls was undertaken at the Franklin Railway Supply Co., beginning in 1937. This effort was led by Will Woodard, who as Lima Locomotive Works' vice president of engineering had been the intellectual father of the Super-Power designs of the 1920's. Leading designers such as Woodard had long been intrigued by the potential of poppet valves, and some had offered proposals as early as 1934.

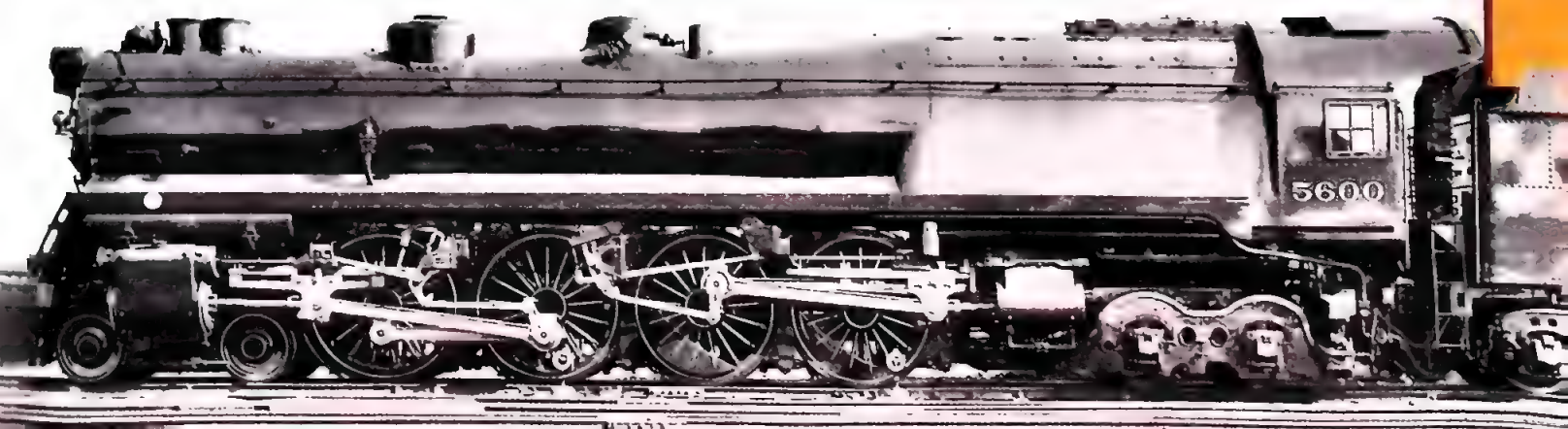
Seeking to improve its large fleet of simple but sturdy K4s Pacifics, the Pennsylvania Railroad contracted with Franklin in 1938 to equip one of these engines (No. 5399) with the poppet system. First, No. 5399 was fitted with a new cast-steel cylinder saddle that contained separate steam chests for each valve chamber. Then a large control box was mounted on a lengthened pilot beam, located on the centerline so as to produce symmetrical connections to the cam boxes adjacent to the steam chests. During its first series of road tests in fall 1939, the engine performed brilliantly. Inside the attached dynamometer car, the output data displayed an increase of 24 percent in drawbar horsepower at 60 mph (compared with a conventional engine) and a whopping 45 percent increase at 80 mph. Later tests at PRR's stationary test plant confirmed these results.

However, at this point PRR seems to have lost sight of its primary objective, namely to produce a better valve gear. Surprisingly, it sent the locomotive to Lima for additional improvements in its steam-generation capability, including a front-end throttle, new superheater, and an improved boiler-tube design. While turning the 5399 into the most powerful U.S. 4-6-2, Pennsy had made it difficult to interpret the cause of the improvements by mixing two sets of experiments. Thus many skeptics argued that the improved performance came mainly as a result of the other modifications, rather than the poppet valves. While the Franklin system was clearly a major advance, the limited testing had not proved that its poppet controls would be reliable in the hostile environment of everyday operation.

Naturally, Franklin's conclusion was that its system offered the best way to effect significant improvements in high-speed operation. It promoted specific proposals to the PRR (rebuild-

B&O's pioneering 4-4-4-4 duplex of 1937 featured a forward-facing rear engine, watertube firebox, and clean British styling.

B&O



ing an M1 4-8-2 into a Northern with poppets) and to Southern Pacific (equipping with poppets some *Daylight* 4-8-4's then under construction), but no new programs could be initiated because of the outbreak of World War II. Thus, poppet valves remained only a future possibility, albeit with some strong data for support.

DUPLEX RUNNING GEAR

A duplex-drive configuration seeks to diminish the rail-pounding forces produced by large, fast locomotives such as the 4-8-4. Baldwin's chief engineer, Ralph Johnson, proposed such a configuration as far back as 1932, when he approached the Baltimore & Ohio about a design that split the eight coupled driving wheels of a 4-8-4 into a pair of four-coupled engines, each with its own smaller power cylinders and valve gear. The result was a rigid-frame 4-4-4-4 locomotive, in which the second set of cylinders was placed between the second and third drivers, thus lengthening the rigid wheelbase.

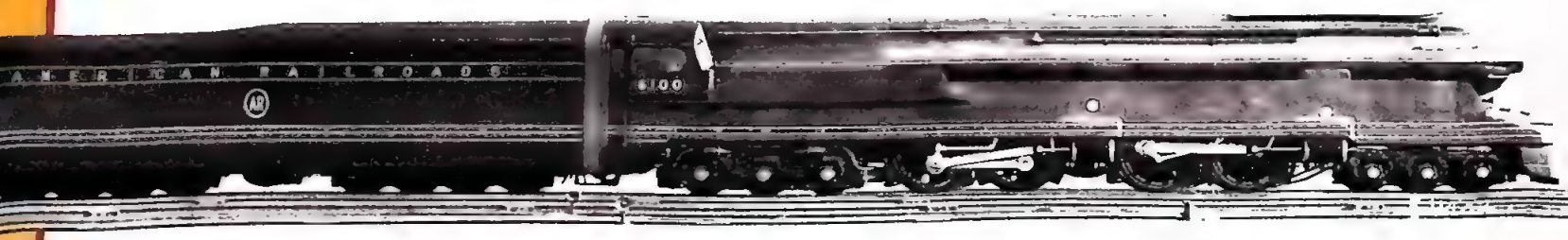
Although initially rejecting Johnson's design, B&O later decided to pursue this approach in its own shops. The *George H. Emerson*, a 4-4-4-4 named for B&O's chief of motive power, was completed in May 1937. In an effort to minimize the long wheelbase, designers used opposed pistons, with one set of cylinders near the cab. But, like many other experiments of this period, the *Emerson* appeared at the wrong time, just as B&O began receiving it first Electro-Motive passenger diesels, which put an end to further steam development on the B&O.

But the duplex concept did not die there. In parallel with its poppet valve research, the PRR began to look seriously at divided-drive locomotives.

After extensive conversations between its own designers and representatives of the three builders, Pennsy settled on a passenger engine of epic proportions: a 6-4-4-6 weighing over 300 tons and running on 84-inch drivers. With a cast-steel main frame longer that that of a Union Pacific 4-12-2, this monster would be capable of generating 6000 h.p. and moving a 1200-ton train at 100 mph. Engine 6100, PRR class S1, rolled out of the road's Altoona shops in 1939. Its futuristic styling was the work of industrial designer Raymond Loewy, who had streamlined K4s 3768 along the same lines in 1936. The S1, after receiving much national publicity at the New

PRR's colossal S1 6-4-4-6 was lettered AMERICAN RAILROADS for display at the New York World's Fair, where it ran on rollers.

PRR



E. T. HARLEY PHOTO, AL CHIONE COLLECTION

Scooping water into its immense tender from the track pans near Hanna, Ind., a T1 cruises east with PRR's *Manhattan Limited* in July 1946. Alas, diesels are on the way.

York World's Fair, proved to be both fast and powerful—and very slippery. Moreover, it was such a behemoth that it was incompatible with everyday needs; its extreme length, for example, restricted the Big Engine (as PRR people called it) to the line between Chicago and Crestline, Ohio. During the war, its fancy skirting was removed to facilitate maintenance. The S1 was scrapped in 1949, after a short 10-year career, but it greatly influenced PRR motive-power development.

Not surprisingly, Baldwin's Johnson had not been a strong supporter of either the B&O or PRR designs, and in 1939 convinced his company to build another duplex locomotive as a national demonstrator. Before construction began, however, Baldwin's sales staff scurried around to court potential buyers with specs, drawings, and artist's renderings of the radical styling by Otto Kuhler. The demonstrator was never built, but in July 1940, Pennsy ordered from Baldwin two 4-4-4-4's, to be called class T1.

The T1's were designed to pull 11 80-ton cars at 100 mph, and had lateral-motion pedestals on the first and third drivers to allow passage through 17-degree curves. The 80-inch-drivered T1 weighed about the same as a mid-sized Northern, although its 16-wheel tender (when loaded) weighed 80 percent as much as the engine itself. The first T1, No. 6110, was delivered in April 1942, and the second, 6111, followed in May. Soon the futuristic-looking pair, also styled by Raymond Loewy, were racking up strong performances in the Harrisburg-Chicago passenger pool.

After 120,000 miles of service, the 6110 was sent to PRR's Altoona (Pa.) test plant in April 1944, and exhibited a maximum of 6100 drawbar horsepower using a 15 percent cutoff. Sensing it had the steam equivalent of its capable GG1 electric locomotive, PRR ordered 50 more T1's in 1944, splitting the order between Baldwin and Altoona. This turned out to be a colossal miscalculation. While the T1 fleet was under construction, PRR received its first road diesels, an A-B-A set of EMD E7's. More diesels quickly followed. Only two years after the last T1 was delivered in August 1946, PRR President Martin Clement announced that, "By May of this year [1948] we expect all of our through passenger trains west of the electrified territory to be dieselized." This statement was part of a press release announcing a $16 million order for diesel locomotives (both passenger and freight).

Was the T1 just another victim of the diesel revolution, or was it a flawed design? As might be expected, the answers are Yes and Yes. It seemed the T1 did suffer from some of the same problems as the S1 in terms of adhesion, but there was also a serious disagreement between Baldwin and PRR about the T1's valve gear. The builder preferred the reliable Walschaerts motion, while the road wanted to plunge into mass production of the Franklin poppet system it had tested so successfully on K4s 5399. Baldwin argued that it was unwise to combine two major departures from conventional practice (duplex drive and poppet valves) in one locomotive. The customer had its way, and the T1 fleet was built with poppets. One T1 was later converted to Walschaerts gear, but was never tested thoroughly so that a direct comparison with the poppet-equipped engines could not be made.

Was the duplex design fundamentally flawed? Moreover, were the T1's test-plant results not indicative of road performance? As to the first question, the early duplexes (of both B&O and PRR) were well designed and constructed, but in reality they were revolutionary machines, featuring greater differences from a conventional locomotive than the designers anticipated. Also, the T1 was rushed into production while still in the prototype stage. In contrast with most other roads, Pennsy had essentially no experience with modern steam locomotives when the diesel began to make inroads just before World War II. Thus it lacked a knowledge base for a new generation of steam power. It was forced to hurry through the T1's shakedown period, in which final flaws are normally removed from a new design. With the diesel at the doorstep, PRR did not have the luxury of thoroughly testing a few prototypes extensively in road service before signing a production contract. Observers of the period also noted that the railroad had indeed put too much credibility in the test lab data, forgetting that these carefully controlled running conditions are far less rigorous than everyday operation.

Concerns about adhesion problems on the T1's led to a study by a mechanical committee of the Association of American Railroads. The committee recommended that such designs have higher factors of adhesion, since driver slip usually means there is too much power for the weight on drivers. But there was also considerable evidence that the T1 was extremely sensitive to who was at the throttle. Some Pennsy engineers said they had no problems with slipping, and gave the T1 high praise. Others swore at their employer for putting such a terrible machine on the rails.

Clearly the T1 was a sound design that would have been more successful had it appeared a few years earlier, with sufficient time for PRR to tackle the weight-control difficulties separately from the valve-control problems.

DUPLEXES FOR FREIGHT

If we make a final judgment about duplex steam locomotives based on the T1's experiences, we will fail to comprehend the entire evolutionary process. In parallel with the T1's development, Baldwin and PRR were also crafting a duplex design for freight, a locomotive that would not represent such a daring leap in technology as did the T1. To put five sets of drivers on the rail within the shortest wheelbase, the experimental Q1 design, like B&O's *George Emerson*,

JIM BUCKLEY PHOTO, AL CHIONE COLLECTION

PRR Q2 4-4-6-4 6181 heads a westbound freight past Englewood station in Chicago in December 1950. The Q's kept to PRR's west end, which was dieselized early.

employed opposed power cylinders, which also helped diminish dynamic loads from the piston strokes but produced other problems with locating the rear cylinder saddle near the firebox. Baldwin built a single prototype, with a 4-6-4-4 configuration, in 1942. It was hefty, weighing as much as a typical Challenger, and had a tractive effort of 115,800 pounds (including 15,000 from a booster). Somewhat unusually for a freight engine, the Q1 was streamlined, though to a lesser degree than the T1. The Q1 had a T1-sized 16-wheel tender and was fitted with roller bearings throughout.

Not completely satisfied with the Q1, PRR ordered a modified version in 1944. On this locomotive, PRR class Q2, the cylinders were conventionally located, and the wheel arrangement was 4-4-6-4. At the Altoona test lab, the Q2 was outstanding, producing the largest horsepower ever recorded by a steam locomotive on a dynamometer. Its 8000 indicated horsepower at 57 mph, with a water evaporation rate of 137,500 pounds per hour, caused the road to proclaim, with justification, that the Q2 was "the most powerful steam locomotive in the higher speed range." Soon Altoona was at work on an order of 25 more Q2's, which it completed in 1945.

The Q2 represented a significant advance over Pennsy's previous leader in freight service, the J1 2-10-4 (a wartime adaptation of C&O's T-1 2-10-4 of 1930). Although the duplex had the same number of drivers as the J1, its improved running gear produced about 2000 more horsepower than the J1 on the Altoona test plant. The amazing improvements produced by the duplex running gear at speed are illustrated clearly by the relative piston-thrust values. Each of the J1's pistons produced a thrust of 178,300 pounds, whereas the Q2's pistons shoved with 92,000 pounds (front engine) and 133,000 pounds (rear).

And the Q2 was capable of doing more, with less, than other roads' highly visible fast articulateds, whose maximum horsepower was in the 6000-7000 range. The Q2 produced a higher peak horsepower, yet had only five driving axles (vs. six or eight for the others), and it had the smallest cylinder displacement of the group (one of the primary advantages of the duplex arrangement). It clearly represented a significant improvement over anything before it, and was in the estimation of many the most advanced American steam locomotive ever built. Certainly, it was one of U.S. railroading's best-kept secrets. ■

Streamlining and an opposed-cylinder layout marked PRR's lone Q1 4-6-4-4, which had 77-inch drivers, vs. 69 on the Q2's.

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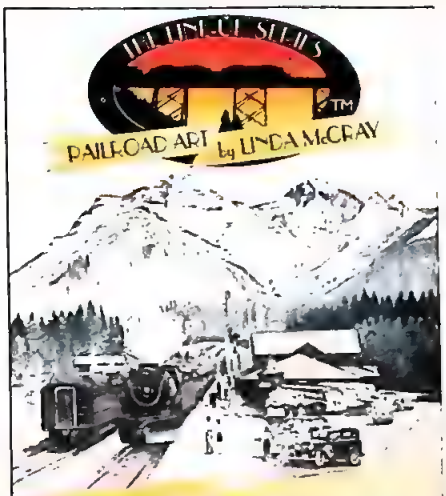

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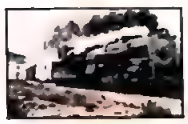

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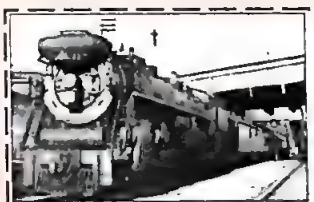

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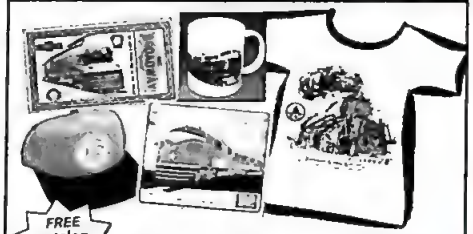

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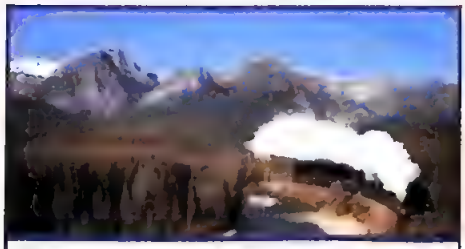

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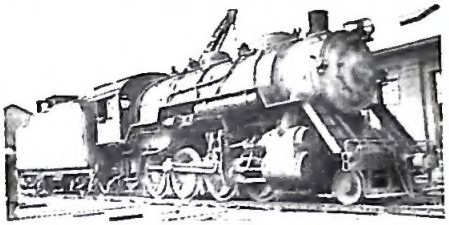

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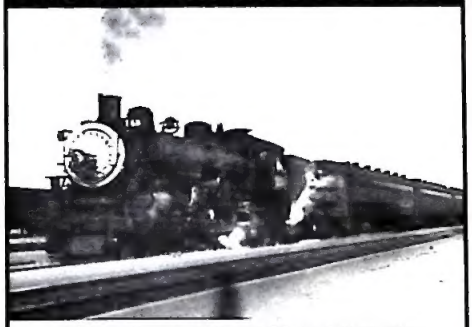

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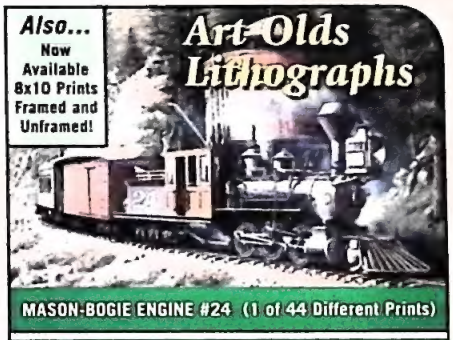

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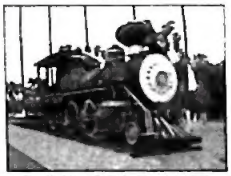

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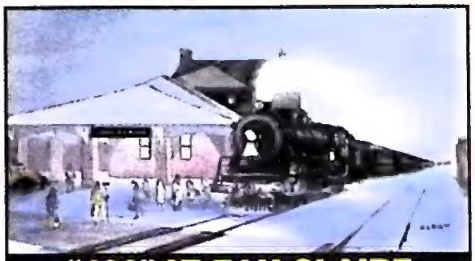

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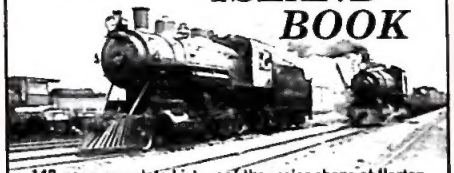

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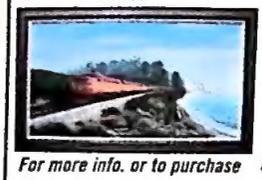

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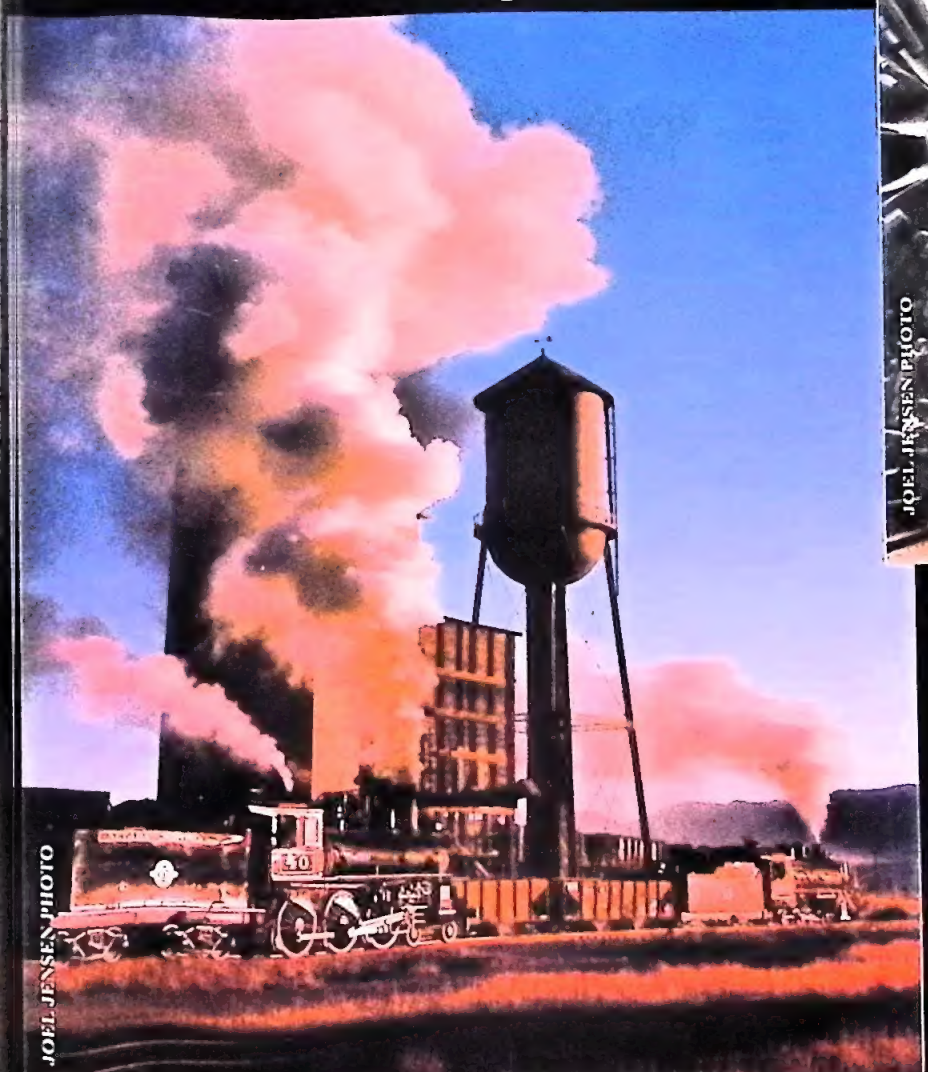

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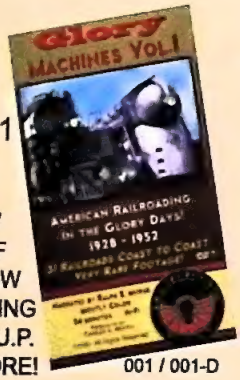

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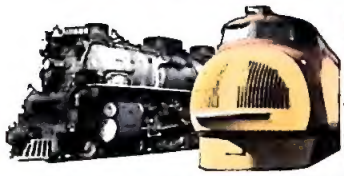

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